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THE PSYCHOLOGY OF CHESS AND OF LEARNING TO PLAY IT.

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In this study an attempt is made to sketch the psychology of the game of chess, to trace the stages in the development of a chess player, and to interpret this progress in psychological terms. That the task, owing to the complexity of the processes involved and the impossibility of applying anything like satisfactory objective tests, is a difficult one, is obvious, but it is one that seems to the writer worth attempting.[1]

I. The Psychology of the Game.

Chess is, as every one knows, a mimic battle fought upon a field of sixty-four squares with pieces moved according to an elaborate system and having powers suggestive of a variety of fighting units. The purpose of each player is to checkmate his opponent, that is, to hem in and threaten the latter's king in such a fashion that he is subject to capture at the next move. In our discussion of the psychology of the game it will be convenient to consider it first as a form of human play and then to take up more particularly the mental powers involved.

1. *Chess as a Form of Human Play.*

Forms and Varieties of the Game. The game of chess has not been confined to any particular age, race, country, or class. It is without doubt one of the oldest, if not the oldest, of the intellectual pastimes, and it is the game of skill *par excellence*. Its origin is not definitely known and there have been many claimants for the honor of its invention.[2]

Especially in its later history the game has developed a number of off-shoots in specialties which for many people share the interest of play across the board. The chief of these is the composition and solving of chess problems, which now has quite a literature and many devotees. Another is correspondence play, in which the strict rules of the typical game are somewhat relaxed on account of the peculiar conditions of play. Others, practiced as feats, but of especial psychological interest, are blindfold playing, to which Binet has devoted a special research,[3] and the playing of many games at once (either blindfolded or with sight of the board). To some of these special forms we shall return later.

It is a pleasure to acknowledge my indebtedness to Professor E. C. Sanford for the suggestion of this topic of study, and for generous assistance in following it out; to Dr. C. A. Drew and others at the Massachusetts State Farm for courtesies extended; to those who in the capacity of assistants have contributed much to this study; and to all who have answered my questionnaire on chess or assisted in securing answers to it.

[2] The history of chess may be followed in Forbes's History of Chess, and in Dr. Van der Linde's book on its history and literature.

[3] Binet, Alfred: Psychologie des grands Calculateurs et Joueurs d'Echecs, Deuxième Partie, Paris, 1894.

Instinctive Factors in Chess Playing. Chess is, as we have said, a game of wide distribution and popularity. Dr. Emanuel Lasker states that over one million English speaking people know the game, that there are in the United States, England and Canada between seven and eight hundred good sized chess clubs, many of which have over one hundred members each, and that the City of London Club has over four hundred members;[1] and judging from the number of chess clubs, chess periodicals and players of high rank in Germany, France, Russia, Austria, and Poland chess is no less popular in those countries. If one were asked what class or classes of people play chess one might truthfully reply that all classes play it.

The question then arises: Why has chess proved so widely popular at all times and in all places? How has it been possible for a game making severe intellectual demands to hold a place historically and in geographical distribution beside such universal forms of human play as gambling, horse-racing, athletics, and hunting, and to claim devotees, if less numerous, at any rate as loyal as any of these? The answer is, of course, that, in common with a multitude of other games and sports, it appeals to the fundamental instinct of combat, in a way that is direct and at the same time exempt from the anti-social features that are inherent in actual physical combat. Here lies a large share of its attractiveness, and its capacity for stirring emotion. It takes hold upon those suppressed survivals of savage impulse (if we are to credit the savage alone with a first hand liking for a contest) which in their modified exercise have been shown to be so large a factor in adult sport.[2]

In this, however, it shows but the typical qualities of the genus to which it belongs—that it is one of the strongly competitive games.[3] Its own specific attractiveness lies in the fact that it is a competitive game of *skill*, more particularly of intellectual skill as opposed to merely manual or bodily dexterity; it is a contest of scheme against scheme; it is a game of generalship.[4] Each particular situation appeals to the player, not only as an occasion for attack or defense, but also as a situation to be met by taking thought, a difficulty to be seen through and overcome, a problem to be solved. There is, therefore, in chess playing all the challenge that lies in baffling but fascinating problems and much of that which lies in the solution of puzzles. That the interest in this aspect of chess is real and important is abundantly evidenced by the growth of the chess

[1] Lasker's *Chess Magazine*, Vol. I, No. 1, Nov. 1904. p. 48.
[2] Patrick: The Psychology of Football. *Am. Jour. Psy.*, Vol. XIV, 1903, pp. 368-381.
[3] Groos: The Play of Man, New York, 1901. pp. 173 ff.
[4] Groos: *op. cit.*, p. 190.

"problem," of which we shall have more to say presently. Lindley in his "Study of Puzzles"[1] holds it likely that in the puzzle solving passion we have a form of the preparatory play impulse to which Groos rightly attributes so much of both animal and human play.[2]

Still another factor of interest in chess is the pleasure of invention and origination, the pleasure of being a cause.[3] In the returns of my correspondents a decided preference is expressed for original plans of attack and defense.[4] Most say that they get away from the standard book plays as soon as possible after the first few moves. Some say that they play from book not from choice, but from necessity; but most say that while they follow the book openings for a few moves, they prefer to get away from them as soon as they possibly can without detriment to their game. They prefer their own game because it is more real, and is a better representative of their own ideas. As one player puts it, "There is little satisfaction in catching your opponent on a line of play that you have simply memorized." There are, also, of course, various practical reasons for this preference. An original plan throws both players on their merits and removes the game at once, so far as possible, from a mere memory exercise, thus depriving a player of the advantage which a superior memory or a better knowledge of book games might give. There is an advantage to the player himself in an original plan in that his game is more likely to be a unit and consequently more consistently played than one partly remembered and partly originated. While the inability to remember particular lines of play is undoubtedly a determining factor in the choice between an original plan and what is known as book play, nevertheless, there is something attractive about a game which one feels to be his own, especially if it is successful.

In summary we may say of chess as a form of human play that in the first place it is a contest, and, as such, it appeals to the fundamental fighting instinct, the instinct which in every normal individual impels him to measure his skill with that of

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[1] Lindley: A Study of Puzzles, *Am. Jour. Psy.*, VIII, 1897, pp. 431-493, especially p. 437.

[2] Groos: *op. cit.*, pp. 369 ff.

[3] Groos: *op. cit.*, p. 385.

[4] In order to supplement my own observations and those of my assistants, a questionnaire was submitted to chess players of different grades of ability. The list of players answering is a fairly representative one and contains the names of some of the best amateurs of the United States and Canada. Some of the data from this source are specifically included in this study, but in many other cases the substance of the views expressed has been incorporated without more acknowledgment than is here made. About 100 answers in all were obtained.

others. In the second place chess offers its devotees opportunity to exercise their ingenuity in the solution of problems and puzzles, a form of pleasure that may well rest upon that general interest in the unknown which at one time must have had the greatest survival value. It would seem further, that intellectual activity is indulged in for the pleasure which such activity gives in itself, and sport of this kind is, perhaps, an expression of the general play instinct. "Intelligence," as Lindley holds, "is no exception to the law of exercise. Just as those animals, which by fortunate variation were born with a tendency to indulge in preliminary exercise of those activities which were to serve the serious ends of adult life, were favored by natural selection, and were able to transmit such advantages in the form of general play instincts, so in a more special way those creatures, endowed with the strongest tendencies to exploit the intelligence, may have perpetuated this superiority as a general intellectual play instinct."[1] Again, the chess strategy of an individual is largely the product of his own brain; it is his own, and merely as such is interesting to him. No matter where or how he got his knowledge of the game, if he is anything of a player, he has assimilated it and made it a part of his mental self, and his game, in turn, reflects something of his personality. There is also what might be termed a secondary, derived or æsthetic interest in chess, namely, in the finer and subtler points of the game, in what the chess world calls its "brilliancies." Appreciation of and consequent admiration for the skill of others is a contributory element in this pleasure. And finally it is, notwithstanding its own exacting demands, a means of mental relaxation and as such is attractive to the mental worker.

2. General Features of Chess from a Psychological Point of View.

The Emotional Effects of Play. We have already alluded incidentally to the emotions which may be stirred by the chess combat. The desire to win is fundamentally connected with the fighting instinct.[2] Young and ardent players especially find the elation of victory and the bitterness of defeat by no means small; they work hard at the game and feel the outcome in proportion to their efforts. The chess manuals and maga-

[1] Lindley: *op. cit.*, p. 437.

[2] This instinct in man, we are told, is being gradually overcome or suppressed. It would be interesting to note, however, whether in the contests which still give opportunity for it, there is any lessening of the desire to win, and whether individuals change at all in this regard. The fact probably is that the instinct is changing its form with social pressure, but losing little of its native power.

zines repeat suggestions as to how one should wear his laurels or accept defeat, but in spite of this well intended advice every chess club has its members who invariably make excuses for every lost game. A good many players, however, have the sportsman's feeling strongly developed and are not unpleasantly affected if they are conscious of having played well. They do not enjoy winning if their victory is the result of a "fluke" on their own part or of a palpable oversight on the part of their opponent.

Personal and Temperamental Differences of Players. The opinion is general among chess players that a man's temperament enters into his play and determines its style. Many of my correspondents state that they have recognized and often utilized this factor in actual play by forcing an opponent to adopt a line of play for which he was unfitted by temperament. For example, a slow, careful game is played against the aggressive and daring player, who is often provoked by these Fabian tactics into recklessness and loss.

Chess players are also very firm in the belief that one's game is an index of his character in a wider sense, and no one will be likely to deny that the fundamental traits of character are revealed in unimportant matters especially when one becomes so deeply absorbed that he forgets all else. Chess offers just such an opportunity for deep absorption, and it is not unreasonable to suppose that one's real rather than his conventional character will reveal itself.

3. Attainments of Players of Average Experience.

In order to form some conception of the skill and knowledge which a chess player of average experience possesses, let us consider (a) his ability to plan moves ahead and to anticipate those of his opponent; (b) to disentangle a complicated situation; (c) to reconstruct the status of an unfinished game from memory; and lastly, (d) his "position sense." For information on these points I shall, of course, have to depend almost wholly on the replies of my correspondents.

Ability to Plan Moves Ahead. It is evident from the variety of answers to the questions on these points and the qualifications attached to many of them that the questions were interpreted in a variety of ways. Some points seem clear, however. The number varies from position to position, is dependent upon the number and positions of the pieces and the player's physical and mental condition at the time. Very few stated any definite number of moves which they thought they usually planned ahead, but allowed a considerable margin. The following are typical of the answers received:—"five to ten," "two to six," "two to ten," "six to ten," "three to seven."

Very few state that they are unable to plan at least three moves ahead in a complicated situation. Four, five, and six are favorite numbers.

Most state that they can anticipate as many of their opponent's moves as they plan for themselves, and that they do so habitually. A few state, on the other hand, that they can anticipate only a much smaller number of their opponent's moves.

Almost without exception my correspondents write that practice has greatly increased both numbers, but especially the number of the opponent's moves that can be foreseen. A few who have played a great many years or who seldom play now, say that the number has decreased. While with most players the increase in number has been considerable, the increase in accuracy has been the main gain. The beginner, owing to the great number of possibilities, is not able to plan far ahead and scarcely thinks of his opponent's plans at all. A little later he plans two, three, and four moves, but he overlooks so many possibilities that his plans are practically worthless. Progress in this regard consists first in the increasing ability to perceive the most likely and feasible continuations both on his own part and that of his opponent; second, in refusing to reconsider lines of play after going over them carefully once and discarding them; and third in increased ease, rapidity and accuracy in calculation.

Visual Imagination. It was asked "Can you imagine, pictorially, what difference in the position a move would make, or are you absolutely without such an image, relying wholly on successive associations of one move with another?" The answers seem to indicate that there are three classes of players in this regard. There are, first, those who have a clear visual picture of the situation as it will appear after a series of moves; secondly, those who have some visual picture, but rely also on successive associations, in verbal or possibly motor terms, of one move with another, that is, they are unable to picture a resulting situation, but must build it up move by move by means of visual and other kinds of imagery. With these players the final term is probably held in verbal terms. The last class of players are those who are without a visual image of any sort. The first class is perhaps the smallest. The players in this group state that the presence of the pieces is not only not an aid in planning combinations, but that it is a positive hindrance. They have difficulty in imagining a piece in a changed situation or on a square which is at that time occupied by another piece when the pieces are on the board before them.[1]

[1] Binet: *op. cit.*, p. 236.

Binet quotes Selkirk approvingly as saying that in working out a plan one is obliged to represent to himself the position of the pieces after each supposed move and that the sight of the board only confuses. Dr. Tarrasch, the German master, holds that all games are played in part without sight of the board and that consequently visual imagery is an essential factor in planning moves ahead, especially in far reaching combinations.[1] This statement, it seems to the writer, is valid only for players of the first class mentioned above. The players of the second group have some picture but find the presence of the pieces indispensable; while those of the third group rely wholly on the presence of the pieces. In some cases this dependence on the pieces is largely a matter of habit, since the players state that while they rely almost exclusively on successive associations, nevertheless, they can often discover errors in their games when the board is not before them.

Ability to take in Large Sections of the Board. Most of the players state that when getting ready to move they can readily take in the whole disposition of their men, or, in other words, they can comprehend the board as a whole. This ability to take in readily the whole disposition of the men is generally regarded as one of the signs of a considerable degree of chess skill. Ability in this regard varies with the physical and mental condition of the player and with the complexity of the situation. The explanation of the gain in skill of this sort seems to be that, as a player progresses in skill, the game takes on more and more meaning and that the individual moves become more and more a part of a definite series or of a number of series each with some particular end in view. The different moves and situations, also, as they are handled in larger masses, are dealt with in an increasingly symbolic manner. A more detailed consideration of this will be taken up in another section.

Reconstruction of the Status of an Unfinished Game. Little or no trouble is experienced by most players in setting up an unfinished game from memory, provided the game itself was interesting and too great a time had not elapsed. The number of pieces on the board is also a factor, though it would appear that it is not of very great importance. A very few state that they can do this only when they are playing regularly. One player reports that he retains a position in correspondence play for a month without difficulty, and another that he is engaged at present in eleven correspondence games and that he retains the positions in all of them without reference to his record.

Different methods are employed in the reconstruction, but all

[1] Binet: *ibid.*

are reducible to two types, namely, setting up the final position, and replaying the game from the start. Some are able to do either. There are different varieties of the first method. Some seem to have a mental picture of the whole board and to arrange their pieces accordingly. They have photographed the situation as a whole and the eye tells them if anything is out of order or missing. Analogous to this in a small way is the ability to see a misspelled word in proof-reading. Others also reconstruct the final position as a whole, but do it by remembering crucial situations and building around them. This memory may be in terms of almost any sort of imagery, but it is most likely to be in visual terms. Verbal imagery also plays an important part. The plan of attack or a certain situation in that attack, is very often the central point from which the position is built up. This would mean that the steps which had been planned ahead were also factors in the recall. Sometimes it is necessary to begin back of the final position at some important place and to build up to it. The second method, that of replaying the game from the beginning, means the running over of a series of successive associations aided and guided by the critical points and by the general plan of the whole game which gives a meaning to the individual moves. The reconstruction from memory of a position involving any considerable number of pieces is not possible to most beginners. If they are of the photographic mental type they get lost in the mass of impressions which the situation involves, and if of the verbal or some other type the situation has not sufficient meaning to give definite place and order to so many pieces.

"*Position Sense.*" Among chess players and writers on chess great stress is laid on what is called "position sense," that is, the knack of knowing in an intricate situation how to place the men to the best advantage. It is a common observation that many chess players are able to tell at a glance which player has the better position without being able to give offhand any reason for the opinion. It is even stated that many players are able to give a correct judgment at times without being able to carry out the analysis necessary to prove its correctness. Bird, the well known English player, used often, in consultation play, to point out the move with the remark that the others might analyze as much as they liked, but that he felt and knew that it was the right move, and it is said that he was generally right. With scarcely an exception all who answered the question stated that they have noted a considerable improvement in "position sense." Many state that improvement in the sense of position and chess improvement are one and the same thing. This latter statement is a little too sweeping, however, since it does not necessarily follow that the mere

knowledge of the strength or weakness of a position will enable one to choose the best of the infinite possibilities which arise at every step. Experience is the blanket term which most use in the attempt to explain the development of "position sense." The player is said to "feel" the position or the proper move. Some interesting reasons are given, however, to account for the ability to judge a position at a glance. In brief they are somewhat as follows: The mind has been drilled to feel any deviation from principles; it is due to a vague idea of similar situations leading to success or failure; it is the recognition of several fundamental points of strength or weakness; and lastly, it is a symbolic shortening, a dropping out of intermediate processes of inference. Perhaps we should not be wrong in saying that it is all of these. It is undoubtedly the product of experience and involves the same sorts of psychic processes that are employed in the formation of general ideas—abstraction and generalization. Players of equal experience differ so widely in "position sense" that it seems reasonable to suppose that there is a difference in their native endowment in this capacity, just as, according to Professor James, people are differently endowed with the capacity for memorizing. "Position sense" is, however, not dependent on memory alone.

Different Grades of Chess Players. Certain mental qualities are essential to the chess player who attains any degree of proficiency whatever, and players differ both in their relative and their absolute endowment of these qualities. Master players combine to a marked degree an accurate and persistent chess memory, quickness of perception, strong constructive imagination, power of accurate analysis and a far seeing power of combination. It is impossible to say just what the proper proportion of these qualities should be, and to be ideal it would have to be modified to meet each new opponent. When these various qualities are combined in something like the proper proportion we have what is generally designated as a separate quality, namely, "judgment." But when we say that a player has good judgment in chess do we mean more than that he combines in something like the proper proportions the qualities which make up the uniformly consistent and successful chess player?

4. Attainments of the Chess Masters.

We have attempted to give some idea of the endowment of the chess player of fair ability and have avoided all reference to the remarkable achievements of the chess masters. The feats of some of these are certainly marvellous, and one is apt to think that genius alone can account for them. The chess ex-

pert displays his skill under one or all of four forms, namely, Simultaneous Play, in which several games are played at the same time against as many opponents; Blindfold Play; Recapitulation of Games played by himself or others; and, in actual play, by the Announcement of the End of the Game several moves before that event.

Simultaneous Play. In simultaneous play the lone player, of course, never plays against those of his own rank, but usually against strong local players who are able to take advantage of any oversight. As examples of what can be done, the following, recorded in the different chess magazines, may be cited:—Gunsberg played eighteen games simultaneously against as many opponents, winning fourteen, losing three and drawing one; Bird played nineteen, winning fifteen, losing one and drawing one; Herr Schallop in four and one-half hours played forty simultaneous games, winning thirty-three, losing five, and drawing two; Lasker played twenty-two games, winning nineteen, losing two and drawing one. Since that time he has often played thirty games simultaneously. As an example of the rapidity of moves made in simultaneous play Napier's twenty-one games should be cited. During the first hour he made four hundred and fifty moves, an average of nearly eight per minute. Of the twenty-one games he won eighteen, lost two and drew one. Evidently simultaneous play requires the ability to focus the attention strongly on a single game, to banish for the time being every other game from the mind, to call up instantly at the sight of any board just what combinations it had been planned to carry out there, and finally to recognize and meet a situation promptly. In all such feats experience is an indispensable factor. The player who plays several games at the same time relies on his knowledge of position, gained through long practice, to give him a quick grasp of the essential situations as he passes from board to board.[1] This factor and the power of concentration seem to account for the distinctive features of simultaneous play.

Recapitulation of Games and Other Feats of Pure Memory. The recapitulation of games is a feat of memory pure and simple. The player simply plays over, or dictates from memory games which he himself or which others have played. The games thus enumerated may consist of fifty or even more moves on each side making sometimes a total of one hundred or more individual moves. Morphy, the next morning after his blindfold contest against eight other players at Paris, dictated to his secretary all of the moves in each of the eight games. Morphy's

[1] A player of perfect "position sense" could play any number of games *ad hoc* without recalling anything.

secretary, in his book entitled "Exploits and Triumphs in Europe of Paul Morphy," gives the following account of the performance:—"Next morning Morphy actually awakened me at seven o'clock and told me if I would get up he would dictate to me the moves of yesterday's games. I never saw him in better spirits nor less fatigued than on that occasion, as he showed me for two long hours the hundreds of variations depending upon the play of the previous day, with such rapidity that I found it hard work to follow the thread of his combinations."[1] In speaking of Morphy's knowledge of games played by Anderson, he writes: "With his astonishing memory he gave me battle after battle with different adversaries, variations and all."[2] And in another place, "What wonderment he has caused with his omnipotent memory. I have seen him sit for hours at the Divan or the Regents, playing over, not merely his own battles, but the contests of others, till the spectators could not believe their senses."[3] Morphy himself made the statement that he had never forgotten a game that he had played after his chess powers were mature. Blackburne likewise has a tenacious memory for his past games. In 1899 he recalled any number of games which he had played in 1862, pointing out with the utmost precision the flaw or the beauty in each.[4]

In regard to the recapitulation of games it should be noted that the player is recalling a number of known situations each the result of a well known series of moves, and that each game as a whole is constituted of, and characterized by, a number of situations joined together by distinctive features which may consist either of individual moves or of combinations of them. The case is similar to that of a remembered conversation; the one who recalls it does not recall each word separately but rather the *meaning* of each remark and its connection with what preceded or followed.

Other Feats of Memory. Blackburne, without sight of the board, is able to give the moves known as the knight's tour, which consists in placing the knight on any designated square and making it strike in succession every square on the board. This is by no means an easy task with the board in sight, a fact of which any one may easily convince himself. Aside from chess Pillsbury performed some rather difficult memory feats. If any portion of a deck of playing cards was called off

[1] Edge, F. M.: Exploits and Triumphs in Europe of Paul Morphy, N. Y., 1859. p. 164.
[2] Edge: *op. cit.*, p. 187.
[3] Edge: *op. cit.*, p. 187.
[4] Graham, P. Anderson: Mr. Blackburne's Games at Chess. London, 1899. p. 207.

to him, he was able to name the cards remaining in the deck. On one occasion, after playing blindfold games for two and one half hours, during the intermission, a list of thirty words, numbered from one to thirty, was read to him. He memorized the words in groups of five taking ten minutes in which to complete the task. Then he was able to give the word corresponding to any given number or the number corresponding to any given word and to repeat the whole list either forward or backward.[1] He made use, of course, of some mnemonic device and the case is interesting only as showing what can be accomplished in that way.

Announcement of Mate in Advance. The announcement of mate several moves ahead means, in case it is not merely a remembered position, that the player has looked ahead of the actual play and is able to say the precise number of moves necessary to bring about the end of the game. It is a common thing for players of the first rank to announce mate five or six moves in advance and their combinations in the middle game often reach beyond that number. Blackburne, in one of his blindfold performances, after the twentieth move, announced mate in six moves more and then called off seven variations which exhausted the position.[2]

Marshall, in London, announced mate in eight moves and proceeded to accomplish it in spite of all his opponent could do to prevent it. The longest mate ever announced in blindfold play was one by Blackburne in sixteen moves.[3]

In some cases planning ahead, as was suggested above, is a simple act of memory. The player may merely recognize the situation as one previously seen and may remember the individual moves which followed and the result; or he may pass directly from the first term, the situation, to the last term, the result, recalling at the same time the number of moves, but not the moves themselves. Where the player has never reached mate from the given situation, but is able to foresee it, he must possess the ability to work through mentally all the situations which come between the one given and the final one, which calls for good powers of analysis and memory as well as experience.

Blindfold Play. The feats which have caused most wonder and admiration are those of blindfold players. Playing without sight of the board is now one of the most common forms of exhibition chess, and it has been said that almost every good amateur can play at least one game *sans voir*.

Paul Morphy, during his triumphal tour of Europe, created

[1] *British Chess Magazine*, Vol. XX, p. 399.
[2] Graham: *op. cit.*, p. 209.
[3] Graham: *op. cit.*, p. 211.

great astonishment by playing eight simultaneous games blindfolded. It is said by competent judges that some of his most brilliant games were those played in this way. Zukertort played twelve and fourteen games very frequently, but often remarked that the two additional ones made it much more difficult. Blackburne is one of the strongest of the blindfold players, but the greatest of all thus far in this line was the American, Pillsbury, who played as many as twenty-two blindfold games simultaneously, winning most of them. With him the number of games seemed to be limited only by the length of time required to complete them and by his physical endurance.[1]

Pillsbury, in an exhibition given at Toledo, Ohio, played twelve games of chess and four of checkers without sight of the boards, and at the same time played duplicate whist.

Such are the feats of blindfold play by the masters. What shall we say in explanation of them? Memory certainly plays a very important rôle, but it may be chiefly of the short time variety, that is, the player holds the moves in mind only during the progress of the play and forgets them immediately afterward, much as the student or the lawyer does the facts he has crammed for a particular occasion. Pillsbury, in an article, said that he had to think rather hard to recall the opening in any given game of a series five minutes after the contest ended.[2] Morphy, on the other hand, seemed to retain his games permanently.

A blindfold player, playing a single game, must have in mind at every stage of the game the position of every piece on the board, and he must have some way of knowing or of calculating the relation of each piece to every other, facts which are not necessarily involved in mere place memory. His knowledge of these positions and relations must be sufficiently clear to enable him to form combinations for attack and defense. In playing eight, ten, twelve, sixteen or twenty games simultaneously without sight of the boards, the task is, of course, immensely more difficult, since the player has not only to remember a proportionally greater number of moves (or positions) but has also to remember each move or set of moves in relation to the particular game in which it is made.

The blindfold player, playing several games simultaneously, usually employes devices to make his task less difficult. Pills-

[1] The physical endurance required for play in such contests is something little realized by the uninitiated. Morphy, at Paris, played for ten consecutive hours without eating or drinking anything. Paulsen, who played as many as ten games blindfold, played twelve consecutive hours on one occasion with no refreshments of any kind except a little lemonade.

[2] Pillsbury: The Chess Player's Mind. *Independent*, Vol. LII, p. 1104.

bury grouped his games and used the same opening in all games of a group. For instance, in playing sixteen games he grouped them as follows: group one contained boards 1, 5, 9, 13; group two, boards 2, 6, 10, 14; group three, boards 3, 7, 11, 15; and group four, boards 4, 8, 12, 16. It will be noticed that two groups contain odd and two even numbers, and that there is a difference of four between any number of a group and the one next to it—1, 5, 9, etc. The blindfold player usually has first move on all boards and can generally force his opponent into his system. If not, he may regroup the boards according as they do or do not fall into his system of play, or he may simply make a mental note of the boards on which eccentric replies to his opening moves have been made. Obviously, so long as the games in each group proceed without variation from the usual moves and replies, there is little chance for confusion, but very soon the game begins to vary. By the time this happens, however, the player has noted some distinctive feature by means of which to recall any game. Pillsbury put it in this way: "By the time twenty moves have been made there has been some clearing of the board and a definite objective has been developed. When I turn to the new board I say—Ah! number nine. This is the board on which we have exchanged queens; and the whole play comes back to me."[1]

In other words, the variation itself, because it involves some distinctive feature, is the cue for the recall of all the moves that have preceded it and those which grew out of it. It will help us to understand this if we recall the fact that chess is, as Binet puts it, a contest between ideas, and that each move is but a part of a series all working together toward the same end, or in other words, each move is remembered because it is a necessary part of a plan.[2]

He points out further that those who retain in mind a situation or a series of moves have the faculty of giving to the situation or the series a precise significance. A person ignorant of chess could not, of course, do this and so would be unable to hold such things in memory. Mr. R. L. Newman also, experimenting upon checker players in the laboratory of the University of Indiana, found that a long series of moves in checkers, made in the presence of his subjects, was remembered only after some form of grouping was employed and that the series was learned quickest by those who understood the purpose of the different moves.[3] The purpose caused the individual moves to hang together, so to speak.

[1] Pillsbury: *op. cit.* [2] Binet: *op. cit.*, p. 264, p. 274.

[3] Mr. Newman's article has not been published, but the manuscript was placed at the writer's disposal through the kindness of Prof. E. H. Lindley of the University of Indiana.

Binet[1] concludes with M. Goetz that the memory employed in games without sight is above all a memory of reason and calculation, or more concretely, that one does not remember that he has moved his king at such and such a time, but remembers a certain project of offence or defense in accordance with which he has moved his king. He qualifies this in part, however, by the statement that sometimes individual moves which make a deep impression on the mind and awaken astonishment are recalled individually. One retains a game of chess as he does a printed line or paragraph; the meaning and not the individual letters or words are what is retained.

Both Taine and Binet have studied the question of the visual representation of the board by the blindfold player. Taine concluded that such a player sees the board and the pieces on it as in an "interior mirror." He quotes an unnamed American to the effect that at the beginning of a game he sees clearly before his mental eye, the board and the exact appearance of each piece, and that after the announcement of each move he sees the pieces in the new arrangement, in exactly the same way.[2] The method of Dr. Tarrasch is thus described by Binet:[3] At the start he represents the board in its original condition. When he makes the first move he sees the board thus modified and keeps the new impression in his mind's eye, and so on through the game, his mental picture changing with each move. Binet's correspondents, with one exception, answered that they used visual memory in playing without sight. He concludes from their answers that there are two forms of visual memory used in blindfold chess, which he designates as concrete visual memory and abstract visual memory. Players who make use of the former see the forms and the colors of the pieces and squares on the board exactly as they are. Abstract visual memory is described as follows: Most of the players see the board mentally. The mental image is localized before the player, but he apperceives at one time only the part of the board where the interesting features of the battle are taking place. The board does not ordinarily have a particular form. It is an abstract board composed of sixty-four squares. Very often the edges of the board are not seen. For some players certain diagonals, having particular importance for the game, are seen more clearly than others. Often the colors of the squares are not clearly seen, but become grayish, one color being a little brighter than the other. The form seems to be the element which is the most difficult to efface from the mental image.

[1] Binet: *op. cit.*, pp. 270 ff.
[2] Taine: On Intelligence. New York, 1899. pp, 38, 39.
[3] Binet: *op. cit.*, pp. 276 ff.

What Binet calls the geometrical notion often takes the place of color. Binet's correspondents are unanimous in the opinion that they represent to themselves the positions of the pieces and their spatial relations and that no combination would be possible without such representation. Charcot gives the name "geometrical visual memory" to that kind of visual memory which simply conserves the positions and the movements of the pieces.[1]

In agreement with Binet we may say that this kind of memory is the work of abstraction and results from the direction which the player gives to his attention. Form and color are neglected because they are of little importance. This abstraction, as Binet points out, is comparable to that in daily life where we gradually eliminate details and give attention only to essentials.

It seems evident from Binet's study, and from the statements of many chess players, that visual imagery in varying degrees of clearness from the most perfect representation to the most shadowy, is a very important factor in playing chess without sight, and that most players make use of it; but there is, on the other hand, data to warrant us in saying that it is not an absolutely indispensable factor. In other words, it is possible that a blindfold game could be carried on by a person entirely devoid of visual imagery. M. Goetz, in his paper published in Binet's book, says that visualization is almost entirely absent in his blindfold play and that his performance depends only on "reason and calculation."[2] For example, he knows from experience that a pawn on the king's fourth attacks one on his opponent's queen's fourth, and that a knight or a bishop on a certain square controls certain other squares; and this knowledge may be retained in verbal terms. Pillsbury, the greatest of all blindfold players, also asserted that he had little or no visual imagery and that he remembers each board and the positions on it not as a picture, but as a record.

Even in my own limited experience in blindfold play, I have found that visualization is an incidental and by no means essential factor. In my own case, in the beginning, visual images were entirely lacking, a little later they were present at times as the result of a conscious effort to call them up, and now when they are present they are so only in the most indefinite form. For instance, I have no mental picture of the board aside from its general outline, and the forms and colors of the pieces are never present, except when I have paid particular attention to them for experimental purposes. In the beginning, localization of the play was very indefinite and a replay-

[1] Binet: *op. cit.*, p. 311.

[2] Binet: *op. cit.*, pp. 340-351.

ing of the games with the board furnished many surprises both in this regard and in regard to the relative positions and distances of the pieces. At the present time the movements of the pieces and the localization of the play are fairly definite. I seem to feel the movements of the pieces, especially my own, as if I were actually moving them. Particular positions involving two or three pieces are sometimes seen in so far as the relative positions of the pieces are concerned. Normally I am a fair visualizer, but in blindfold chess my thinking seems to be largely of other sorts, and especially in verbal terms. When not engaged in actual play I frequently call up a situation with a fair degree of clearness, but when playing, verbal imagery is the most prominent in consciousness. For example, my opponent announces knight to the king's fifth. Ordinarily I do not picture the resulting position, but calculate the radius of action of the piece thus: knight on king's fifth attacks queen's seventh, bishop's seventh, etc. If it is advanced to queen's seventh it checks king at knight's first, etc., etc. It would seem that there is a closer association between the series of verbal images than between the visual images or the series composed of both verbal and visual images. My experimenting has not gone far enough, however, to furnish very much that is definite in regard to this aspect of the question. Without visual imagery the blindfold player would have to rely on word, letter and number symbols, and would have, it would seem, a much more difficult task than the player with highly developed power of visualization. In actual play, verbal memory plays an important part even for strong visualizers, for it is often by this means that they recall the actual moves that have been made when they are in doubt as to the position of any piece. My companion in the attempts at blindfold play made considerable use of visual imagery of Binet's abstract type, but used other sorts to a certain extent. I am inclined to believe that with increasing experience both of us would have made more use of verbal and other symbols.[1]

In order to determine whether it would be possible to play chess with no visual imagery whatever, the following experiment was tried. Games were played without the use of either board or chessmen. The records were kept in the German notation, but in such a way that each player could tell the number and the location of the pieces on either side. The moves and replies were thought out as far as possible with the aid of this record and in terms of the symbols used. For instance, P a 5 attacks any pawn or piece on b 6; Kt c 3 attacks

[1] It may be conjectured that the necessary concentration of attention on the *relations* of the pieces rather than on the pieces themselves is partly responsible for the incomplete development of visual imagery.

b 1, a 2, a 4, b 5, d 5, e 4, e 2, d 1, etc. It was thus possible to calculate the relative positions of the different pieces and to attack and to defend any given position. The experiment was not long continued and visual imagery was never wholly absent, especially where attempts were made to form combinations. Nevertheless, I am convinced that it would be possible for a person to learn to play chess by means of verbal and number symbols alone. The task would be a very long and difficult one, but by no means impossible.

The Relation of Chess Skill to General Mental Ability. If chess is perhaps a tolerable index of temperament and character, is skill in chess also a reliable index of mental power in general? The reply must be qualified. Many able men are good chess players, but on the other hand there are those who live for chess, who think, talk, and dream chess, who confirm Edgar Allen Poe's observation that the best chess player may be only the best player at chess; but this number is small compared to the vast majority who indulge in it only as a pastime. Even among chess masters are to be found many who have displayed considerable ability in other lines. Dr. Emanuel Lasker, the present world's champion at chess, has taken his doctorate in mathematics. Tschigorin is a Russian government employee, Maroczy is a professor of physics and mathematics at a Budapest college, Tarrasch is a German physician, Anderson, at one time champion of the world, was a professor of mathematics, and Staunton, another world's champion and one of the best known of the older chess writers, is well known also as a writer and as an editor of the classics. Rousseau, Voltaire, Napoleon, and John Stuart Mill are said to have been strong players, and the historian Buckle an excellent one. The list might be increased almost indefinitely, but enough has been said to indicate that skillful chess players represent all walks of life, and that skill at chess is not incompatible with success in other lines. The chess player is usually something more than a mere player of chess. At the same time the cases of *idiots savants* in various forms of mental activity, and among others in chess playing, prevent the inference that skill in chess is a universally valid index of high mental endowment.[1]

5. Special Psychology of Chess.

Forms of Mental Activity Required. We have now followed sufficiently, perhaps, the general aspects of the game, and can turn with advantage to its more intimate psychology. The aim of each player is, as we have said, to checkmate his oppo-

[1] See in the appendix to this study an account of a fair chess player of otherwise feeble intelligence.

nent, that is, to bring his own pieces into such a position that the opposing king could inevitably be taken at the next move. Each player must therefore carry out a scheme of attack, overcoming obstacles and preventing the blocking of his own plans, and at the same time guard himself from counter attack. The game in its most important portion presents in essence a succession of situations each of which calls for special examination, with reference both to its present and its future import, and the selection or invention of an appropriate line of action. The player asks himself continually, in effect, at least, what is this present situation and what ought I to do to meet it? The game throughout may be regarded as a series of reasoned inferences, expressed by moves upon the board. The present section will be devoted to an exposition of the logical and psychological relations in question.

The Stages of the Game and Their Logical Types. The game of chess proper is divided into three fairly well defined parts called the opening, middle, and end games. There are openings without number but all have been the subject of analysis for so long that one can obtain from the numerous books on the subject information limited only by his capacity to retain it. The competent player knows at least the chief openings and enough of their theory to meet any unexpected variation from the usual moves and replies.

The end game, in which the forces on either side are greatly reduced, has also received careful study at the hands of expert analysts, so that one may learn from the books to recognize certain situations and to know their possibilities. Geometrical figures have often been employed to show the possibilities of situations.

In the middle game, however, the player may no longer rely on definite directions, but is entirely dependent on his knowledge of general principles and his past experience. The former will be of service especially to the young player, but, owing to the infinite number of possibilities which may develop out of the different situations, experience in actual play is indispensable. Here the player must exercise all his ingenuity, must give rein to his creative imagination, and must follow out as far as he is able the effects of the different moves which suggest themselves. The chess player's skill is measured in terms of his ability to do all this successfully.

Opening and End Games. In the opening game and in the end game the logical type of reasoning is usually that of the categorical syllogism. In case of a typical opening it may be formulated as follows:

In all cases of the Evan's Gambit, pawn to the queen's knight's fourth is the fourth move.

This move is to be the fourth in an Evan's Gambit.

Therefore, this move should be pawn to the queen's knight's fourth.

Similarly in the end game the situation which develops recalls the procedure to be followed. If White, for example, has a king and a rook against Black's king, he must drive the latter to the edge of the board, hold him there with his king and mate with his rook. White's procedure may again be reduced to the type of the categorical syllogism.

All cases of king and rook against king are to be met by driving the latter to the edge of the board, etc.

This is a case of king and rook against king.

Therefore, this is a case to be met by driving the king to the edge of the board, etc.

All habitual actions may be reduced to this type and Professor Charles Pierce has remarked the same about all reflex actions.

The Middle Game. In the middle game, where general rules are only partially applicable, the logical procedure is mixed and will differ somewhat according to the grade of the player. In what follows immediately we shall assume the player's condition to be that of a not very skillful amateur; of the professional's condition we shall speak later. So far as general rules apply to the middle game, the play will be of the deductive type which we have just illustrated, but in the vast majority of cases it will be more complicated. The situation is not of the known sort that invites application of general rules, but of an unknown sort in which the essential features (or true meaning) must be disentangled from a mass of obscuring details, and when disentangled must be met by a move or a line of play especially selected, or invented, for the purpose. The logical type is not now simply deductive, but really a series of logical steps resembling the sort of scientific procedure which Jevons, for example, calls the "Combined or Complex Method."[1] An hypothesis is first formed, deductive inferences drawn from it, and these tested by experiment. The player finds before him a situation created by the last move of his opponent. His study of the situation gives it a certain character in his mind equivalent to the formation of an hypothesis with regard to it. He then reasons: This is a situation of such and such a sort and therefore to be met by such a move in reply. The move in reply is then tried in imagination. If it seems successful it is accepted and actually made; if it is seen to be unsatisfactory, it is rejected and a better one sought for the same purpose, or

[1] Jevons: Lessons in Logic. New Ed. London and New York, 1905. p. 258.

what is more likely, the hypothesis itself (the conceived character of the situation) has been changed by the evident unfitness of the move imagined.

Skill is shown in the opening and end games by the readiness with which the player recognizes the common situation and draws from memory the appropriate response. Skill in the middle game is shown by the readiness with which he recognizes the essential features of a new situation, and, in his inner experimentation, hits upon a move that fits the case, *i. e.*, proves by its appropriateness that his diagnosis of the situation was correct.

This is the condition of the commonplace player. The case of a perfect player, one with chess omniscience, whose analysis was perfect, who could see the game to the end at any stage of it, would be quite different. Having a perfect plan of procedure for every case, he would play throughout very much as the amateur plays the opening and the end games. Excellence in play ranges upward from the condition of the amateur toward that of the perfect player. To the chess master many of the situations that arise in the middle game are already familiar and the best means of meeting them known. Others will be unknown; and then the crucial point of his opponent's attack must be discovered and an appropriate response devised. His play is for the moment of essentially the same type as that of the amateur, except that he is both by nature and experience much more prompt in discovering the essential feature of the attack and much more resourceful in finding means of repelling it.

Let us, however, return to the logical type employed by the commonplace player. The type followed in the opening and end games would correspond closely to the typical logical procedure as described by James.[1]

The type followed in the middle game differs from the formal sketch of James which has in view reasoning of the deductive type. Here the essential characteristic of the situation, even when discovered, does not suggest any well known group of similar cases to which it may be referred and for which a definite mode of procedure has already been worked out. The essential characteristic can at the most suggest only a very general kind of procedure; it gives no inkling of just what should be done. The player knows that he must sacrifice the threatened piece, or withdraw it, or intercept the attack, or make a counter attack, but which of these is best must be thought out for each situation. His usual method is to try in imagination one move after another until he finds one that seems superior

[1] James: Principles of Psychology, N. Y., 1899, Vol. II, pp. 330 ff.

to all the rest. And often it is only during this experimental process that the full signification of the situation dawns upon him.

Such reasoning is concrete and practical, not put into words, or only partially so, and allied to the reasoning of animals and children.[1]

But, as Morgan well shows, the logical reasoning of man is largely dependent on the need of communication and the use of language;[2] a chess game *played* is reasoned in particulars; the same game *explained* and *defended* to a companion would be cast in verbal and syllogistic form.

Psychological Restatement of the Logical Types. This last remark touches upon an essential point to which we must give yet a little further attention, namely, the difference between the logical types of reasoning and the actual psychological processes which they symbolize. All processes of reasoning are, as psychological facts, sequences of mental states due to shifting of the focal point of attention and to processes of association dependent thereon. In the deductive portions of the game—the opening or end game, where the play is guided wholly by rule—the process is one of serial association running off under the general influence of the conception of the opening (or end game) which remains in the background of consciousness. Each move suggests the next in fixed sequence, as one might say the alphabet, having in the background of his consciousness the desire to say it.

For the middle game let us take a concrete example. Let us say that it is Black's turn to move. He glances at the board and notices the queen and knight of his opponent in position to develop a double check upon his king. Association, under the guidance of his general knowledge of the purpose of the game, freely suggests the consequences, if he cannot in some way interfere. Attention then shifts to the response to be made and association again coming in suggests the readiest means of defense. In other words, the situation, regarded from the point of view of defense and held in the focus of attention, recalls by association a number of possible moves. These associations, following, of course, the readiest lines of habit, are not by any means at random, but operate strictly within the limits imposed by Black's knowledge of the general rules of play and his present intention. Each of the moves suggested is itself brought to the focus of attention, is tried in imagination, probably by incipient movements of eye or hand,

[1] It is what Romanes calls reasoning in particulars. Romanes: Mental Evolution in Animals. N. Y., 1900. p. 337.

[2] Morgan: Introduction to Comparative Psychology. London and N. Y., 1902. pp. 293 ff.

and accepted or rejected as the case may be. If accepted, it is put into execution in the same manner as other voluntary movements.

The mental action of the player in such a situation is analogous to that of the inventor. A half finished machine stands before him; his problem is clear; he must cause such and such movement in such and such parts in order to bring about a desired result. He runs over in his mind the varieties of pulleys, cranks, gearings, cams and the like with which he is familiar, and finally selects one or the other as the most likely to accomplish what he wishes. A high grade of skill as an inventor or as a player of chess involves the utmost readiness in seeing just what needs to be done and in discovering the means of doing it. Experience helps immensely in both of these directions; and it brings many cases under fixed rules so that they are dealt with by simple associations and correspondingly reduces the number of cases that must be treated as singular and without rule, and greatly enriches the fund of expedients that may be tried in such singular cases. When the case is so unfamiliar that experience suggests nothing, the reasoner is reduced to simple blind fumbling, on a level with that of the brutes, and rational procedure reduces to the "method of trial and error." The situation arouses an impulse to do something; there is a blundering attack; efforts that lead to unpleasant consequences are rejected; those with pleasant consequences are repeated. Man's more complex mechanism of apperception, his wider range of associations, and his power of imaginative action all combine to reduce the cases where blind fumbling is necessary, but when these powers are of no avail there is but one method, and that is the method of lucky hits.

II. The Psychology of the Learning of the Game.

1. *General Description of the Learning Processes in Chess.*[1]

In the preceding sections have been set forth what I conceive to be the general outlines of the mental activities involved in chess playing. It is popularly believed that chess is a very hard game to learn, that it is difficult for every one and impossible for many. To a certain extent this is true. Chess is a difficult game, but it is so because it requires a peculiar mental equipment, rather than because it calls for one of an especially high order. First and foremost is required a liking for chess. The man who finds it uninteresting may as well give it up at once. Next it requires powers of sustained attention and an

[1] My sources of information here are my own introspective notes while learning to play, and those of four assistants, together with the replies of my correspondents.

excellent memory;[1] and based on these, considerable powers of analysis, and visual imagination, or its equivalent in some other sense department.

Increase in skill means increase in the knowledge of chess situations and how to meet them; or, in more psychological terms, increasing "meaning" in certain arrangements of the pieces,[2] and increased facility of association between these meaningful arrangements and certain other arrangements (moves to be made) imaginatively constructed; or, in still other terms, more adequate apperception of the situations and richer and better organized associations connected therewith. These organized apperceptions and associations insure truer and prompter apprehension of the difficulty to be met and better and prompter selection of the means to meet it. Skill is largely, though not wholly, in proportion to knowledge, and knowledge in proportion to experience.[3]

The player's progress may be divided roughly and for purposes of description into five stages. (1) The first step is to learn the names and movements of the pieces. The former is easily done, but the latter requires a trifle of practice before the pieces can be readily used in play. This is especially true in the case of the knight.[4] For successful play the moves must, in the end, become automatic, and this automatism is not reached, as the game is usually learned, in the first stage itself. It depends for its perfecting on the practice obtained in succeeding ones. This probably is the natural method in all learning, the greater interest of the advanced stages floating the learner over the drudgery necessary for complete perfection of the automatisms of the earlier. When the moves have become automatic the men are no longer pieces of wood, jade or

[1] These last may not seem absolutely essential in view of the case to be described in the appendix, but even from that case I shall hope to show that this statement is justified.

[2] Stout: Manual of Psychology. N. Y., 1899. pp. 84 ff.

[3] I say "not wholly in proportion to knowledge," because skill represents only that part of knowledge that can be readily and effectively applied. Our general problem in this section is, therefore, to describe, as far as we are able, the way in which experience becomes transmuted into skill. Our immediate concern is with chess skill, but if we are successful in our study of that, we shall be justified in certain inferences with regard to many other sorts of learning which, like it, are matters of mental as opposed to purely physical training.

[4] Knowledge of checkers is at first a source of many interferences. The player is tempted to move his pawns diagonally, has a tendency to keep his pieces bunched so that his opponent cannot "jump" them, is on the lookout for vacant squares on which to plant his pieces, and has a tendency to clear the board as soon as possible. He also finds it difficult to remember that the pieces can retreat after having been once advanced.

ivory,—static things—but *forces* capable of being exerted in definite directions.

(2) The second stage may be characterized as the stage of individual moves of offence and defense during which the beginner plays with no definite aim other than to capture his opponent's pieces. Even this he blunders about, often overlooking for several moves a chance to capture a man that has been left *en prise*. My notes contain many entries showing two bishops, both unprotected, left facing each other for several moves, or a queen moved within range of a bishop or a knight. The player is able to attack one of his opponent's pieces and is able ordinarily to defend himself against direct attacks. Whichever he attempts to do he must give his whole attention to it, and even with this extreme of concentration he is able to see only the immediate consequences of the move. In general, however, his lack of conception of the aim of the game, causes him to play at random. His play lacks unity and the pieces are moved hither and thither, unsupported and unsupporting; he has no conception of the game as a well planned sequence. Nevertheless he has hovering in the background of consciousness some idea of the ultimate object of the play, the hemming in of the adverse king, and is influenced somewhat by it.

(3) The beginner is soon able to tell at a glance what any single piece can do, but no one piece, not even the queen, is very strong unless supported by others. Hence the task in the third stage of the beginner's progress becomes that of learning the strength, not of individual pieces, but of pieces in relation to each other. He has to learn the value of groups and the value of individual pieces as parts of particular groups. There are times when a bishop or a knight or even a pawn may be so situated that its direct influence is greater than that of a rook or a queen. Many of the most fascinating of the recorded games are those in which one player has actually given away one or more of his pieces, often his queen, in order to gain the advantage of the relative positions resulting from the movement of the pieces involved.

About the time the beginner has passed beyond the first two stages of his learning and during the third, the idea of checking becomes the dominating one with him and his efforts tend to centre upon that exclusively. This, of course, leads to premature attacks which usually result disastrously to the aggressor. He is also prone to fix his attention on his own plans and most likely on the particular part he is about to execute at the moment, to the neglect of all others. He suffers from inability to take in a number of details at the same time. They have no meaning except as details, and if he concentrates on one, others must, by that very fact, be neglected. He has

ittle idea of the importance of developing his pieces, *i. e.*, making them available for future offence and defense, and of the value of position. The attack of his opponent compels some defensive play, however, and no defense can, of course, be made without the co-operation of at least two pieces, so that he soon learns something of the use of pieces in combination. He learns, for example, that often a piece may defend another and at the same time attack one of his opponent's pieces, that in some cases where two pieces are attacked simultaneously one may be withdrawn and so placed as to protect the other, and that a counter attack is often the best defense.

He has made considerable progress in this stage when he is able to give attention to the plans of his opponent beyond those that are immediately connected with his own, though in this particular, temperament plays a large rôle. That this is the usual experience, however, is testified by the fact that after a player is able to form a definite plan of his own involving some use of combination, he is often surprised by checkmate when he is within a single move of checkmating his opponent. He is unable to carry out his own plans and at the same time to give attention to anything else; he is particularly weak in defense.

In general we may say that the beginner at this stage is not able to play in proportion to his knowledge. He recognizes his errors when they are pointed out to him, but he is unable to avoid them. My records show many familiar blunders occurring over and over again. The beginner's material of knowledge is not organized and therefore not available in any situation except the most simple.

(4) The player has entered upon the fourth stage when he begins consciously to plan the systematic development of his pieces. This necessarily involves some knowledge of the value of position, which knowledge we may call judgment of position. These judgments are generalizations and are the result of the player's own experience, or have come to him in the form of general principles from the experience of others. However they may come to the player their possession is absolutely essential to further progress. Now the player no longer has to puzzle himself by attempting to consider all the possibilities of the situation, a thing he is utterly unable to do, but he applies his principle. His principles, especially those he has formulated for himself, are usually only partially true and have to undergo constant modification as his knowledge and experience increase. He knows now a number of definite situations and his plans radiate from these and are more far reaching. He is also in a position to give more attention to the moves and, indeed, to the general plans of his opponent. This is a consid-

erable advance, for it means that the player's mental horizon has been extended very much and that he is able to disregard the non-essentials to a greater extent than before. Given positions assume more and more importance and one of the great marks of improvement is the development of "position sense."[1]

(5) As we have already pointed out, "position sense" is a result of experience, and as such is the product, we may almost say the culmination, of one's whole chess development. Nevertheless, a fairly good knowledge of the value of different positions marks such an advance over the player who is in what we have called the fourth stage that it may be taken as the fifth in the player's course of development.

The stages mentioned above are somewhat arbitrary, and may not be followed exactly in individual cases, but they will at least give some indication of the course of the player's development, which may be summarized in brief as follows: First the names and moves of the pieces are learned. Then comes the period of blunders, of indefinite play, of premature attacks, and of concentration on single moves, particular situations or, at best, on a plan imperfectly worked out. Later, one is able to see farther ahead, to foresee results more accurately, and to give some attention to the plans of his opponent. At the same time some typical forms of attack and defense and some general principles, or supposed principles are being learned, together with some knowledge of position. Along with all of this, though appearing consciously much later, goes an ever increasing power of analysis and improvement in "position sense."

Some of the most common blunders or oversights of these early stages are leaving pieces *en prise*, *i. e.*, unprotected and in a position to be captured on the next move of the opponent; allowing two pieces to be attacked simultaneously by one piece; removing a guarding piece, resulting in the loss of the guarded one; allowing a piece to be "pinned," *i. e.*, leaving it in such a situation that either it cannot, under the rules, be moved at all, or only with loss of an important piece. Errors of a more general nature are overlooking the bearing and force of distant and far-reaching pieces, errors in pawn play, not correlating the pawns and pieces, blocking the radius of action of the men, forgetting the purpose which prompted the placing of a piece in a certain position and a consequent loss of time in replacing it, or a disorganization of forces, and finally, faulty combinations and unsound sacrifices. Many blunders arise at all stages of skill from haste, impatience, and impulsiveness, but they are especially numerous with beginners.

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[1] *Vide*, p. 277.

2. *Discussion of the Learning Process.*

We have now given an account of the stages of learning; it remains to speak more particularly of the psychology of the learning process. Our problem is to explain the development of a beginner, who knows merely the names of the pieces and their powers, into the skillful player who makes use of these simple elements in intricate and purposeful combinations. We have to do with the growth of skill in strictly mental operations within the limited field of chess play.[1]

Obviously, memory is the *sine qua non* of learning, but although of prime importance it is only one of the factors involved. It must be such a memory as leads to the organization of the mental materials rather than to their mere retention. One could not be far wrong in saying that mental skill is in direct proportion to the degree of this organization. How organization can best be brought about is still an open question, and indeed its answer would involve the entire psychology of pedagogy. Its ultimate nature we do not know. To a great extent the material organizes itself, *i. e.*, the organization is physiological and a matter of growth. This fact was clearly pointed out by Dr. Burnham, who holds in his study on "Retroactive Amnesia"[2] that impressions require a certain time in which to fix themselves. The growth process, fixing the impression and strengthening the association tracts, is an indispensable factor in learning. A multiplicity of impressions might be made to follow so closely on one another that none of them could become fixed. In that case, of course, nothing would be learned.

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[1] Numerous studies have been made on memory, attention, and other complex mental processes and a considerable number on learning, but these latter have been concerned chiefly with motor training. Bryan and Harter's study on the learning of the telegraphic language among the earlier studies, is the nearest approach to the present one, but it deals more especially with a sort of learning which is of a mixed motor and sensory type, whereas the skill here in question is almost wholly central. In that study learning on the sensory side consisted in the formation of fixed associations between complex sounds and the corresponding words; in our case the learning process involves the formation of complex groups rather than that of fixed associations of symbol and word. Nevertheless much of what Bryan and Harter discovered in reference to this latter sort of learning is strictly applicable to the form with which we are dealing, especially their chief generalization, namely, that advance in skill depends upon the formation of a "hierarchy of habits." Among the more recent studies, that of Swift, on Beginning a Language, in the Garman Commemorative volume (Studies in Philosophy and Psychology by former students of Charles Edward Garman, Boston, 1906) may be mentioned as dealing like this with a form of mental skill.

[2] Burnham: Retroactive Amnesia, *Amer. Jour. of Psy.*, Vol. XIV, 1903, pp. 382-396.

In this connection I may mention that the returns of my correspondents also indicate that short periods of rest from chess practice, varying with the individual from a few weeks to several months, may cause a noticeable increase in skill. Renewed interest and consequent greater effort in beginning again after an interval of no play may account for this in part, and it may be also that in constant playing the details accumulate faster than the mind can assimilate them, so that they confuse rather than aid the player. This seems plausible when we remember the difficulty the beginner has in applying known principles to a mass of details. Then, too, when the stress of new impressions ceases, an opportunity is given to take an inventory of the mental stock. This is not possible to any great extent when new impressions are crowding in, and the attention is fully occupied with them. On the other hand, long periods of inactivity have a very different effect. Players make blunders in the openings, their combinations are not so far reaching, and a greater effort is required. Every part of the game that requires pure memory is affected and it is often necessary to do consciously what had previously been automatic. This, however, has to do merely with the fixation of separate impressions and of ideas with their associates, and our problem is rather to account for the combination of these elements into larger and larger complexes. On the physiological side little is known. The most that can be said is that increasing complexity of nervous function parallels increasing complexity of mental function. However that may be, our explanation, for the present at least, must be sought on the psychological side.

If we omit the very earliest stages in the chess player's development, the first significant fact is the beginner's utter inability to use in actual play what little chess knowledge he possesses. His blunders are recognized at once when they are pointed out to him, but in spite of his resolution to avoid them, he finds himself committing the same ones over and over again. It seems that the more he tries to avoid them the more blunders he makes. The intensity of his effort and the deep interest he takes in the game precludes mere carelessness. His difficulties are not due to lack of attention, but to the concentration of the attention on one feature of the game to the neglect of all the others. He sees this single thing and nothing more, because it, of all the mass of impressions, has some meaning for him. Were it possible to determine the span of one's chess attention during the different periods of his progress in learning, it would be possible to give objective evidence of the progressive fusion of the different elements into larger and larger complexes. The course of development would extend from the stage in which

the player is unable to see in their completeness even the immediate consequences of a single move to that in which he is able to take in at a glance the disposition of all the pieces on the board. The building up of mental complexes in learning chess and those involved in other sorts of learning are not essentially different. There is a close analogy, for example, between the chess player learning the moves and blundering through his first few games, and the child learning to read, or the telegrapher learning to send and to receive messages.[1] The letter, the telegraphic dot or dash, or the single move in chess is at first the unit of perception. Later the word, a series of dots and dashes, or the relation of two or more pieces to each other becomes the unit. The child learns later, possibly, to comprehend at a glance the meaning of a phrase or a sentence; the telegrapher to receive by phrases; the chess player to take in a whole situation at a glance. Not only has the unit of perception become larger and larger but it has become more and more meaningful.

Perhaps the anology is closer still between the chess expert and the mathematician who has merely to glance at a formula or at its first two or three terms in order to recognize its full import. Every situation in a game of chess which requires readjustment of the player's plans is a problem for him, and the quickness and the accuracy of his solution will depend upon his ability to seize upon the salient and essential features and to neglect those which have no meaning for that particular situation. Obviously the mathematician's skill, when confronted by a problem, will display itself in his ability to recognize the fundamental nature of the problem. Lindley found that an expert mathematician, among those who attempted to solve his puzzle, recognized at a glance the mathematical principle involved and solved it without difficulty.[2] He displayed what corresponds to "position sense" in chess. The chess player has this advantage. In any particular game he has built up or helped to build up his own problem and has a mental record of its progress. He has seen the possibilities of certain lines of play eliminated one by one and is thus able to concentrate on the remaining ones.

The expert chess player is not required to analyze each position as he comes to it, and, indeed, this would be impossible to any great extent. His mind grasps the situation as a whole and it has a definite meaning for him. He recognizes the salient features only and deals with them, the details having for the time being dropped out. He is in the position of the general who has to know not that in one part of the field he

[1] Bryan and Harter: *op. cit.*

[2] Lindley: *op. cit.*, p. 470.

has a regiment of one thousand soldiers, divided into ten companies of one hundred men each, but that he has a force there sufficient to repel any ordinary attack. He has only to pay attention to the regiments and their condition when an emergency arises. The expert no longer deals with particular terms, but with general terms or concepts. These general terms have been built up step by step, their meaning changing with the ever increasing knowledge of the player, and are often represented partially or symbolically by their initial moves or general trend. More concretely, a player learns at first that a certain move is a good one because it has certain definite advantages, and this enables him to plan a little further ahead. Later he finds that this move has a great many other consequences, and perhaps this in turn modifies a general principle he may have based upon it, and this finally, may involve the modification of several other principles and result in a still more comprehensive principle embracing all of the others. Details can be organized into larger groups in proportion as they gather meaning as a group, but not before. The chess player groups his pieces and they acquire a meaning analogous to the potential meaning of the general term or the symbol in abstract thinking. Progress in chess like progress in abstract thinking of any other kind consists in the formation of an increasing symbolism which permits the manipulation of larger and larger complexes.

We are in the habit of speaking of the automatic in the motor realm, meaning by it that certain movements or combinations of movements are carried on without conscious guidance. Is there such a thing as automatism in the realm of the purely intellectual? It seems to me that this question is to be answered in the affirmative. There is something in the purely intellectual life corresponding to motor automatism, which is shown in the ability to think symbolically or abstractly, and thus to handle large masses of detail with a minimum of conscious effort. It involves the increasing ability to take in during a single pulse of attention a larger and larger group of details which means, of course, that the attention is no longer needed for each one.

An apparent difference between motor and mental automatisms, lies, however, in the fact that in the intellectual realm increasing automatism seems to involve the dropping out of details, while in the motor realm increasing automatism often means a greater perfection of the details. Careful examination, however, will probably show that in both details are dropped from consciousness and that in both they are perfected in the externalized outcome. The great feature common to both is the releasing of the attention from the details. In the intel-

lectual sphere, as the processes become more and more complex, they are carried on by systems of symbols which tend to become more and more abstract or general. This is true of all abstract thinking, including that involved in expert chess playing. And, as in all other kinds of abstract thinking, it is essential in chess that no matter how symbolic the thinking may become the player must always have a thorough grasp of the details of the game. In other words, he must not only be able to construct his plans by the use of abstract symbols, but he must be able to translate them into the concrete and to carry them out move by move. This latter he does not necessarily do in his thinking. From one whole situation he passes directly to another whole situation. For instance in a definite situation, the first move of a long series suggests not the next move but the position after the whole series has been played. In other words, the first term does not necessarily call up the second one or the last, or some intermediate term, but the result of all the moves. This final result may be present to the mind in the form of a visual image (a mental picture) or in verbal terms. For example, the first few moves of the Evans gambit already mentioned, may cause to arise in the mind of one player a visual image of the position as it will appear after a dozen moves have been made on each side, while in the case of another player a verbal judgment of the strength or weakness of the final position may take its place. To the latter player this opening calls to mind a verbal judgment of the final position based on past experience. The formulation of principles of play, which become increasingly general, is another expression of the increasing symbolism involved in learning to play chess, but in this case in verbal instead of visual form.

The chess player's skill is measured largely in terms of his ability to use larger and larger units of thought. He has learned by means of many repetitions, a series of moves in regular sequence, later, as has already been pointed out, the first move or a given arrangement of the pieces on the board represents for him the position as it will be several moves further on. All the intermediate steps are for the moment ignored, or, in other words, "a short circuit" has been established and the association is between the first term and the last or the total result instead of each term being revived by the one immediately preceding it.

In trying to explain this from the physiological side two alternatives present themselves. It may be that an entirely new brain tract, connecting the first term with the last, has been opened up. On the other hand it is just as conceivable that the nervous impulse may travel along the same path in all cases and that in the case of a "short circuit" only the first

and last terms rise into consciousness. Experiments on the learning of nonsense syllables, showing that repetitions not only strengthen the associative bonds between a syllable and the one immediately following it, but also between more remote ones,[1] seem to lend a certain support to the latter theory. This is, however, all rather speculative since neurology is able to tell us little or nothing about it. On the psychological side the "short circuiting" process seems to mean something like this. In the beginning the last term, the final result, is reached after passage through all the terms of the series. Now, ordinarily, the series is of value, and therefore of interest, not for itself, but for its result, so that little attention is given to the intermediate links, but much to the getting through. The whole strain of attention is forward. As a result of this the image before the mind may be several steps in advance of the one actually being executed, or, in well practiced series, it may be the last step itself, or even the purpose for which the series is gone through. The result is that there is a tendency to the formation of immediate associations between the earlier and later steps of the series. This suggests that conscious effort plays an important part in the establishment of the "short circuit." Bryan and Harter, in their study of telegraphic language, concluded that only by putting forth a supreme effort could one rise above the plateau of moderate attainment.[2] Still it is by no means certain that the rise in the curve would not take place in time if effort were maintained at a moderate and uniform level. In that case the rise in the curve from the plateau would mean the completion of the growth processes under the guidance of ordinary selective attention.

While chess is a type of purely intellectual learning, the fact should not be lost sight of that the emotional accompaniment is an important factor in the chess player's development as in all other sorts of acquisition, and that emotion is one of the strongest influences in fixing impressions. Ideas which are associated with strong emotions are kept before the mind for a longer period than those which have little or no emotional coloring and thus have much more chance of becoming permanently fixed. Numerous instances were noted in this study in which situations which had aroused strong emotions were continually before the mind and were so persistent as to banish sleep and to drive out all other thoughts.

In this connection mention should be made of the effect of error on one's progress. If one continues to commit errors

[1] Ebbinghaus: Ueber das Gedächtniss. Leipzig, 1885.
[2] Bryan and Harter: *op. cit.*, p. 50.

through ignorance of the fact that they are errors, he may retard his development by falling into fixed habits of unsound play; but if they are noted as errors, and especially if they arouse a strong emotion, they are eliminated. The importance of this becomes evident when we recall that a great part of the player's progress consists in the elimination of unprofitable moves. It is easy to see, also, that emotions, so far as they are expressive of temperament and affect one's habits of play, may exercise an important influence for good or bad upon one's ability to win, as already pointed out in any earlier section.

3. *Aids to Learning.*

By study and practice the difficulties of the beginner are gradually overcome and his faults corrected, though the latter are apt for a long time to recur at unguarded moments, and some, especially the faults of temperament (errors and oversights due to impulsiveness, rashness and quick temper, for example), may never be wholly suppressed. It is probable, indeed, that most of the faults of the earlier stages are temporarily overcome many times before they can safely be given over to the realm of the automatic, *i. e.*, they crop out from time to time when the attention is turned toward larger complexes of elements.

Of all the aids to learning, so soon as one has mastered the bare rudiments of play, there is probably nothing like actual play over the board, provided that one is willing to play slowly, study out the causes of his misfortune and profit by them. The emotional stress attending both success and failure at such a time is a great aid to memory, as has already been suggested.

The concrete criticism of a superior player is of the greatest assistance, but too many things must not be given at once, and what is given must be applied immediately in actual play in order to insure its retention.

In order to get some idea of the sources from which chess players gain their knowledge of the game and the value which they attach to them, questions were asked of my correspondents in regard to the benefit derived from problem solution, the study of standard games, end games and openings, and board play under different conditions. Most, of course, had derived most of their knowledge from actual play over the board.

The interest in problem solving is by no means universal. Many state that they have never attempted to solve problems; others, that they are not interested in them because they are artificial and mechanical and do not help one's general play. The replies indicate, however, that problem solving is widespread among players. As to its helpfulness in general play, the variety of opinion is great, varying from the statement that it is a positive detriment to extravagant claims for its utility for mental development in general. With a number of players, the problem interest, if developed at all, was developed late, *i. e.*; long after they had learned to play. It is interesting to note that few of these players think that problem solving has helped their play. Others took up problems with the beginning of play and say that they were greatly helped by their efforts to solve them. This suggests what is probably the fact that solving problems helps one in the early stages of his play, and this is in accord with my own experience. The reason for this is not hard to find. The history of problem chess shows that in the beginning the problems were merely positions

taken from actual games and consequently involved all the elements of actual play. Much could then be derived from their solution which would be of general service. Since that time, however, problem composition has changed very much, and the problems now are made to conform to certain fixed rules, which have, from the standpoint of many players, made them mechanical and artificial. They have lost most of their resemblance to positions met with in actual play. No doubt they are not of much benefit to players who have had considerable experience and who are familiar with the principles involved in their solution. With the beginner, on the other hand, the case is different. He may learn something of the manner of giving check, something of the powers of pieces in different combinations, and of the value of position. They may help his powers of analysis in so far as they involve general principles which are applicable to actual play, and they may aid in improving his judgment of position. At the best, however, they are far inferior to the study of end games and to actual practice over the board. This latter statement seems borne out in part by the fact that few, if any, great problem solvers or composers are also great players.

Practically all agree that a knowledge of the openings is indispensable. The advantage is evident. It enables one to place his pieces in good positions relative to each other, to develop along sound lines, to avoid disaster in the early stages of the game, to take advantage of weak moves made by one's opponent, and what is also of great importance, it enables him to play with a minimum of effort during the early stages of a game. It should be added that knowledge of the openings and variations helps one to force the play along lines with which he is most familiar. The easiest and quickest way to get this knowledge is from the books, but many good players possess it who have given little or no time to book study. They have gained it from actual experience, and base their opening plays on principles derived from this source.

A few think that replaying standard games does not help one's play, and a still smaller number think it is a positive detriment, assigning as a reason that it destroys one's originality, and causes him to overlook advantages which slight variations from the known lines might give. There may be a real danger here, but it is more than offset by the advantages gained. Among the advantages are mentioned the opportunity to examine positions at leisure, to study comprehensive plans of attack and defense involving particular combinations, to appreciate the value of time and position, and finally to become familiar with a number of oft-recurring situations. These situations, while seldom identical, are often similar. Standard games also teach principles and aid in the development of position judgment. It should be stated, however, that the value of such games varies with the individual, and up to a certain stage is in direct proportion to his chess knowledge. The mere beginner learns little from them; the chess master also learns little from them. The one is unable to comprehend them; the other finds little in them that is unknown to him. The games take on meaning in direct proportion to the amount of knowledge that one brings to them; and their value to any individual depends on the number of new ideas he is able to carry away from them.

Playing with a weaker player is not considered a good thing by most of my correspondents. They say it makes them careless, prone to recklessness, and leads them into all sorts of extravagancies of play. Several recommend never playiug with a weaker player without giving sufficient odds to make the game even. A few recommend playing with a weaker player for the reason that, by lessening the amount of

attention ordinarily given to the opponent's plans, the stronger player is able to give freer play to his imagination than he would dare to do if playing with one of equal strength.

Most say that playing with many different players has made their style more flexible. A few, however, maintain that style of play is individual and that nothing can change it. This contention, as was pointed out above, is undoubtedly true in so far as fundamental traits of character enter into the game. Those who answered that playing with a number of different players has made their style more flexible, appear to mean that to a certain extent it has enabled them to overcome some faults due to temperament and that they have learned a greater variety of methods of play.

III. General Summary of the Psychological Points.

Chess as a strongly competitive form of human play appeals to the fundamental fighting impulse, but it appeals also to the æsthetic and puzzle-solving interests; and it affords the pleasure of "being a cause."

Visual imagination is an important element in chess playing, especially in blindfold chess, but it is not indispensable. Motor, verbal, or auditory imagery may, and often does, occupy the chief place in the player's consciousness.

The mental qualities most utilized in chess playing are: a strong *chess* memory, power of accurate analysis, quickness of perception, strong constructive imagination and a power of far reaching combination. These are *chess* qualities, however, and skill at chess is not a universally valid index of high mental endowment.

The logical type differs in the different stages of a game and with the knowledge and skill of the player, approaching always nearer, as his knowledge and skill increases, to that of the syllogism.

The reasoning process is, in psychological terms, a sequence of mental states due to shiftings of the focal point of attention, the associations working strictly within the limits imposed by the task or purpose.

In his learning the chess player passes through well defined stages and these mark the necessary steps in his progress. The most important psychological feature in the learning of chess (and it seems equally true of all learning), is the *progressive organization of knowledge*, making possible the direction of the player's attention to the relations of larger and more complex units. The organization involves generalization, increasing symbolism, and the multiplication of associations; it insures prompter recall and increased potential meaning in the general concepts; it releases attention from details and favors consequent mental automatisms and "short circuit" processes. Thus alone is progress possible. Mental automatisms are usually perfected, one may conjecture, after advance to the next higher stages of learning.

Appendix: On the Case of a Feeble-minded Chess Player.

During the course of this study several cases of chess playing among the feeble-minded have been reported to the writer, but it has been impossible to secure definite data except in one case. It is said that in some instances a very high degree of chess skill was possessed by men of very low mentality. An inmate of the Wisconsin Institution for the Feeble-minded, is reported to have been able to cope successfully with very strong players. Very likely the strength of these players has been very much overestimated, but the evidence is sufficient to warrant us in saying that in chess as in other kinds of mental activity a peculiar power is not incompatible with a very low average of general mental ability.

The writer has been able to study at first hand one case of chess playing by a man of low grade intelligence who is an inmate of the department for the feeble-minded and criminally insane at the Massachusetts State Farm. In the asylum records he is classed as a congenital idiot who has suffered degeneration since coming to the institution in 1891. Previous to that time he had been an inmate of other institutions for the insane. He has had and still has, though less frequently than formerly, outbursts of rage, at which times he beats his head against the wall. He says he does this because he loves his mother. He is a sexual pervert and some of his outbursts followed his separation from other inmates of the institution whom he designates as "friends." He is fifty-four years of age but looks much younger, is filthy in his personal habits, and presents a very peculiar appearance. He stoops considerably and walks with the shuffling gait characteristic of the feeble-minded. In one of the older asylum records some one has noted the fact that he resembles an anthropoid ape in appearance. His forehead is very low and receding, his maxillaries are very protruding and the posterior portions of his head are so prominent that his head resembles that of the African negro.

The term idiot is used to cover such a wide range of mental deficiency that it conveys no very definite meaning, so that it will be necessary to give a brief account of his attempts at mental work in order to convey some idea of his general intelligence. His memory for some things is fairly good, though it is not of special excellence. He remembers faces quite well and for a considerable time. He also has a fairly good memory for places, remembering, for instance, the town in which he was brought up, the different institutions he has been in, and the town in which some of his relatives live, and remembers all these by name. He has no idea of time, but holds a few dates in mind. For example, he said he came to the asylum in 1891, which was correct. He knows the names of most of the months of the year, but has no idea of their order. In January he was asked what month it was and replied that he did n't know. He was then asked if it were June and replied that it was the month before June. When asked what month that was, replied: "That is the month of October." He has had practically no schooling and can neither read nor write. When asked why he didn't go to school when he was a boy he replied that he was too thick-headed to learn. He repeated this on several occasions.

The following questions were asked him: If you had two apples and I gave you two more how many would you have then? How many are five times five? If you worked for me five days and I gave you a dollar for every day you worked, how many dollars would you have, To all these and to other questions he gave the same answer: "Don'? know." Questions in regard to his name, the names of otherst his age, and other simple questions he answers intelligently or

with his indifferent "Don't know." In this regard he may be compared to a young child. There is this difference, however: he does not show the curiosity of a child, and displays very little mental iniative. He is like a child, however, in another respect: he is very fond of toys, picture books, and especially of neckties. He asks for them repeatedly, but only apparently when he notices them. He enjoyed playing with my watch and with my ring and asked for the latter several times. When told he could not have a thing or promised it later he always replied "Thank you." He is unable to tell time by the clock or watch, but almost always knows the hour of the day, which he is no doubt able to determine from the regularity of the institution life. In reply to a question he said that he is twenty-one years old and that he had been that age for a long time.

In regard to his chess playing I should say at the outset that he is not a strong player, and that an average player of a year's experience could probably play as well or better. It should be remembered, however, that he has never studied the game at all, has never played regularly, and has not played with many different players. There was no way of determining how long he had known the game, except from his own statements and these are, of course, not very certain. He said he learned about three years ago, that no one had taught him the moves, but that he learned them by watching others play. He has played checkers for many years, but there is no trace in his game at present of interference of association from this source. As is to be expected from the circumstances under which he learned, and played, his play shows very little variety, although there was some improvement in this regard as well as in general chess ability during the time I had him under observation. He has considerable familiarity with certain situations and can be relied on to meet them in certain ways. He usually meets a threat, for example, at once and by dislodging the threatening piece if possible. An analysis of his games shows a number of oft recurring moves such as Kt-R3, Q-B3, P-Q3, and advancing a pawn one square to serve as a guard for a piece or a pawn to be advanced at the next move. Attacking a piece with a pawn, and "forking" two pieces are favorite methods of attack with him. He makes his moves very rapidly and apparently with little or no time for consideration, but usually waits very patiently for his opponent to reply. If the effect of a move of his opponent is not very remote, he notes it almost immediately. For instance, on one occasion when a bishop attacked both of his rooks he announced at once that one of them was lost, and on another occasion when his queen was attacked by a knight, he announced at once that she was lost, a fact which his opponent had not yet appreciated. It may be, of course, that he had anticipated the dangerous move.

He had a great deal of difficulty with a set of chessmen of a pattern different from those he had been using. In the new set the king was larger than the queen, while in the old set the reverse was the case. He was utterly unable to use them until, at his request, a piece of colored cloth, which had been tied around the old queen, was fastened to the new one. After that he had little difficulty with the new set.

At times he seemed to see a situation very quickly, but to be unable to retain it in mind when he attempted to meet it. For instance, when trying to get out of check, he moved his king back into check several times, that is, he would find a move impossible, recall it and then a little later attempt it again.

On the whole it is not too much to say that his game compares quite favorably with those of players whose advantages in the way of in-

struction, study, and practice have been much greater than his, and there is no reason to doubt that with more practice and instruction he would be able to improve his game considerably.

Our conclusions from the study of this case must be, it seems to me, that chess skill is not an index of general intelligence, that the reasoning involved in chess playing is reasoning within very narrow limits, and that a considerable degree of chess skill is possible to one who is mentally deficient in almost every other line.

The following records of games played by this player will indicate to those who are familiar with the game something of his chess ability. The games are chosen as fairly representative of his play during the time he was studied, which extended a little over two months, with an interruption of three weeks between the last observation and the one just preceding it.

Game No. 2.

White (feeble-minded player)	Black.
1 P-Q4	P-Q4
2 P-K3	Kt-QB3
3 Q-KB3	P-K4
4 P-QB3	Kt-B3
5 Kt-KR3	QB-Kt5
6 Q-Kt3	Q-K2
7 P-KB3	B-R4
8 QPxP	KtxP
9 P-KB4	Kt-QB3
10 QKt-R3	KKt-K5
11 Q-B3	BxQ
12 KtPxB	Q-R5ch
13 K-K2	Kt-KB3
14 KKt-Kt5	KB-B4
15 Kt-QKt5	O-O
16 P-QR3	P-KR3
17 P-Kt4	B-QKt3
18 KtxKBP	RxKt
19 P-QR4	P-QR4
20 PxP	BxP
21 K-Qsq.	R-K2
22 B-Q2	B-Kt3
23 B-Ksq.	Q-R4
24 KR-Kt	QxBp (ch)
25 K-Q2	QxP (ch)
26 K-Kt2	QxR
27 Kt-Q3	QKtxKt
28 PxKt	BxQP
29 R-Q1	QxKB
30 B-Kt4	Q-QB5 (ch)
31 K-Ktsq.	Q-Kt6 (ch)
32 K-B	32 Q-Kt7 (checkmate)

White	Black (Feeble minded player)
1 P-K4	P-K4
2 Kt-KB3	Q-KB3
3 P-Q3	Kt-KR3
4 B-Kt5	Q-QB3
5 KtxKP	Q-K3
6 B-KB4	P-KB3
7 BxKKt	PxB
8 Kt-QB4	Q-QB3
9 KB-K2	P-QKt4
10 B-KR5 (ch)	K-Qsq.
11 P-Q4	QxKt
12 Kt-QR3	Q-B3
13 P-Q5	Q-Kt3
14 O-O	B-QB4
15 Q-K2	B-QR3
16 P-K5	P-QKt5
17 KPxP	BxQ
18 R-Ksq.	QxP
19 RxB	QxQKtP
20 R-Ksq.	QxKt
21 R-K8 (ch)	RxR
22 RxR (checkmate)	

FLUCTUATIONS OF ATTENTION TO CUTANEOUS STIMULI.[1]

By L. R. Geissler, B. L.

Ever since the term "fluctuation of attention" came into psychological usage, it has been assumed by many psychologists that attention itself is an intermittent, oscillating, more or less rhythmically pulsating condition or state of mind. A sufficient proof of this was thought to be found in the fact that a continuous liminal stimulus periodically enters and leaves consciousness. On the other hand, it has also been shown by several investigators that the unsteadiness of liminal sensations may be due to various other causes. This would not necessarily disprove the oscillatory nature of attention. But the results of an investigation carried on during the last year tend to show that, under certain favorable conditions, maximally concentrated attention to liminal and supraliminal cutaneous stimuli remains approximately constant for at least 2 to 3 minutes, provided that physiological adaptation of the sense-organ and violently intruding external or subjective distractions can be prohibited for this length of time. This is the general outcome of a series of experiments suggested by the incongruity between the results of previous investigators of fluctuations of attention to cutaneous stimuli.

The first experiments of this kind were made in the year 1887, by N. Lange, with a Du Bois-Reymond induction coil.[2] The observer held one of the electrodes in the one hand and placed a finger of the other hand in a vessel of lukewarm water containing the other electrode. Lange found that fluctuations in this sense department were not as plain as in the case of visual and auditory stimuli, and in fact could be observed only after some practice. He thought the reason for this was that in daily life we are hardly ever required and therefore little accustomed to direct our attention to tactual sensations. In 1892 similar experiments were made by A. Lehmann, who also compared the occurrence and duration of electro-cutaneous fluctuations with the periods of concurrent respiration.[3] He

[1]From the Psychological Laboratory of Cornell University.

[2]Beiträge zur Theorie der sinnlichen Aufmerksamkeit und der activen Apperception. *Philos. Stud.*, IV, 1888, 390 ff.

[3]Ueber die Beziehung zwischen Athmung und Aufmerksamkeit. *Philos. Stud.*, IX, 1893, 66 ff.

found a surprising coincidence, which led him to the conclusion that the periodical innervations of the muscles, caused by inspiration, in some way increase the sensitivity of the skin.

Observations of an entirely different kind were made by E. Wiersma, who in 1900 and 1901 investigated among other things the fluctuations of attention to areal pressure sensation.[1] He employed a series of 6 circular weights, 1 cm. in diameter, the lightest being 7.4g, and each following 3g heavier; so that the series extended to 22.4g. These weights ranged for him from a liminal to a distinctly supraliminal intensity. Each observation lasted 5 minutes, after which the observer rested for about 8 minutes. Wiersma found that the total time of complete imperceptibility, as well as the duration of the different periods of fluctuation during a single observation, are proportional to the intensity of the stimulus, and that toward the end of each period of observation liminal stimuli, pressure as well as visual and auditory, tend to (and often actually do) disappear entirely. This tendency of conscious processes to lapse into unconsciousness seems to him to be intrinsic to the fluctuations of sensitivity. Quite different were the results of Ferree's experiments, both with liminal pressure stimuli and with liminal electro-cutaneous sensations.[2] No fluctuations were experienced.

Partly for this reason, we decided to repeat his and also Wiersma's experiments. We also wished to obtain introspective data as to the course and contents of consciousness during the experiment, because we expected them to throw light on the conditions of fluctuation. According to Lange and many others, the intermittences of liminal sensations are due to central causes, *i. e.*, they represent fluctuations of attention; in other words, a liminal sensation periodically enters and leaves consciousness because attention itself is an intermittent or pulsating process. Now it may be true that a minimal lapse from maximal to a somewhat less concentrated state of attention is sufficient to cause such disappearance, without our being able introspectively to observe this slip or lapse. But if it is unnoticeable, then there is no justification for calling attention intermittent; if it is noticeable, then introspection ought to bring it to light. So far as our knowledge goes, no systematic appeal to introspection has been made by the supporters of Lange's hypothesis. On the other hand, Lange's opponents have maintained that intermittences of

[1] Untersuchungen über die sogenannten Aufmerksamkeitsschwankungen. *Zeits. f. Psych.*, XXVI, 1901, 168-200; XXVIII, 1902, 179-198; XXXI, 1903, 110-126.

[2] An Experimental Examination of the Phenomena Usually Attributed to Fluctuation of Attention. This *Journal*, XVII, 1906, 119.

liminal sensation occur in spite of the most concentrated attention, and hence must be due to something else. They have referred this phenomenon to periodical changes in the physiological conditions of the sense-organ or in the sensory centres of the cortex. Introspection would be plainly in their favor if it could tell us, not only what is in consciousness while the oscillating stimulus is subliminal, but also what is the state of attention during the absence of the original sensation; and, especially, whether it is possible for attention to remain maximal while different processes enter and leave its focus during a given period of time. From the 350 introspective records obtained during the course of our investigation, we can, in a preliminary way, draw the conclusion that after some practice it is possible to estimate the degree of attention given to a certain stimulus with fair accuracy, and to notice any shifting of the focus of attention.

I.

For the sake of comparison, we copied as closely as possible Wiersma's arrangements and external conditions. Unfortunately, outside noises could not be entirely avoided. But we tried to eliminate at least all visual disturbances or distractions by using the darkroom for each experiment. The fluctuations were recorded by means of a telegraph key, connected with a stylus writing on a kymograph in an adjacent room. About 300 records were obtained from the following observers: Misses M. E. Almy (A), then a Cornell summer student of slight practice in introspection, and E. Murray (M), a very careful and experienced observer, and Messrs. I. M. Bentley (B), the only observer familiar with the problem besides G, the writer, I. Lande (L), W. H. Pyle (P), and R. W. Sailor (S). Observers M, G, L, P, and S were advanced students in the department of psychology who had had general laboratory training. The first set of experiments, with observers A, B, G, and P, was made during the months of July and August; the second set, with observers L, M, P, and S, from October to December, 1906.

Preliminary trials showed that Wiersma's weights were not liminal for our observers. Nevertheless it seemed worth while for comparative purposes to use his material, and experiments were accordingly made with these weights upon P and G on 6 consecutive days in the order given by Wiersma. The experiments were also repeated for G in reversed order. In the case of the other observers, we were content with one or more observations with each of the 6 weights. At the end of each trial the observer was asked to write out an introspective account of the course and content of consciousness during the

experiment. In about 165 trials Wiersma's arrangements were exactly followed, in the remainder some modification as to weight, time, or area stimulated was introduced. The latter will be treated separately later on. The results obtained from A, B, G, and P were entirely opposed to Wiersma's. These observers recorded no fluctuations whatever, but stated that the weights could be perceived even if attention were not directed toward them. But this wandering away of attention from the stimulus occurred almost only in the second half of the experiment, that is to say, after about 150 sec. of maximal concentration; for we must remember that each observation, according to Wiersma's direction, lasted 5 minutes, which is undoubtedly too long and too fatiguing. Other characteristics of the introspective records appear in the following quotations:

Observer A. Weight 16.4g. "Seemed so heavy that I had only to think of it as a weight to keep it in mind. It fluctuated in apparent amount of pressure and in degree of attention, but was easily held in consciousness throughout the time."

Weight 13.4g. "Kept weight in mind by verbal ideas and by projecting my mind on the periphery of the weight as the sensation lessened. I allowed it to slip only once, when by comparing the two hands I decided there was no feeling; and I started to press the key and found I was feeling, though very faintly; the movement of the right hand emphasized its freedom from weight."

Weight 10.4g. "It almost escaped me, as I thought about the weights and what they were made of; but I snatched the pressure sensation back just as it began to fade from consciousness. I felt that the weight was too light to be held easily in mind, and I had to think of it more attentively than I should have to think of a heavier one."

Weight 7.4g. "Had by effort from the beginning to keep weight in first level (*i. e.*, highest degree) of attention, because it was so light and fluctuated in intensity so that I could sometimes hardly feel it. Disturbing noises once almost put it out of consciousness; nevertheless it was voluntarily held at second level. I think in words to keep my attention on it—spoken words to myself—and try to banish all other thoughts. Kept comparing the surfaces of the two hands to be sure the weight could be felt."

Observer B. Weight 13.4g. "Slight throbbing of blood in last part of interval. Surer this time of no fluctuations. Interrupting distractions from fatigue in arm. Some associative trains obscured stimulus. A tremendous strain!"

Weight 10.4g. "Heavy. Distinct throbbings of blood in back of hand and index finger. Pressure lighter in last part of interval. As before, I seem to come back to pressure and clear it up after distracting associations. Pressure seems *not* to have lapsed and returned."

Weight 7.4g. "In last part of experiment, bad throbbing of pulse in volar fore-arm caused some distraction. Just at end I was doubtful whether pressure was still present (yes?)."

Observer P. Weight 19.4g. "Attention on weight throughout, and had richer sensations than usual. Pain came in after about a minute. I thought a few times there was a flash of cold. I can still feel sensation after weight is removed."

Weight 13.4g. "Felt weight well. Its sensation changed, a little painful toward end. Many things passed through my mind, staying only momentarily."

Weight 10.4g. "I kept saying to myself: weight, weight, in order to be sure of my attention. Occasionally I felt my arm underneath and sometimes I noticed my breathing."

Weight 7.4g. "A little difficult at times to feel weight. I would become doubtful and attend very closely, the weight at such times then plainly felt."

"A little painful at times and very faint at last. Could hardly tell whether I felt it or not."

The introspections of G, the writer, are perhaps less valuable than the others, although in their main features they differ little from the rest. A few actual disappearances of the lightest weight, due to some unavoidable distractions, occurred in his case.

Summarizing now the observations of A, B, G, and P, we find (1) that a supraliminal areal pressure stimulus applied to the skin will gradually change its original character as to quality and intensity, and either disappear altogether after 2 or 3 minutes or persist as a simple, indefinite, vague, and unpleasant irritation, which is perhaps sometimes confused with a resulting pressure after-image. (2) These qualitative changes or fluctuations of intensity (due to physiological conditions) are noticed only when and presumably because attention is concentrated and becomes more concentrated the fainter the stimulus grows. (3) After sufficient practice it is possible to estimate with fair accuracy the degree of attention given to different stimuli or to the same stimulus at different and especially critical moments. (4) It seems probable that attention can remain maximal even while different mental processes enter and leave its focus, at least for a few minutes. (5) The weights were heavy enough to press the muscles beneath, and also to emphasize the beating of the pulse (B and G) against the resisting contact surface of the weight; these things served either as distraction or as a criterion for the presence of the stimulus. (6) The slightest movement in the upper part of the body increased the pressure to a surprising degree, probably because it involved a slight movement of the stimulated surface of the hand. The last two points serve to emphasize the fact that very close attention involves great muscular strain. It is possible that breathing, under such conditions, periodically causes greater tension and relaxation of the muscles of the chest and arms, and hence indirectly brings about the (often rhythmical: B and G) fluctuations of intensity in the pressure of the weight upon the muscles underneath the skin. Of course these results cannot fairly be compared with Wiersma's, because the stimuli were not liminal; and therefore another set of experiments had to be made for the purpose of getting liminal pressure sensations.

Unfortunately, it was impossible to continue with the same

observers, except P, and hence our new observers, L, M, and S, had to begin afresh with Wiersma's series, in order to determine whether for them these weights were liminal or not. At first sight this seemed to be the case, but the introspections proved the contrary.

For example, L recorded the following fluctuations (indicated by the minus sign preceding a number) in the first set of observations taken:

Observer L.

No.	Weight.	Fluctuations in Seconds.
1	7.4g	+ 58-2+179-6+25-4+13-13
2	10.4g	+136-2+11 -9+55-9+44-14+14-6
3	13.4g	+ 69-2+36 -4+42-7+32-7 +47-10+10-16+18
4	16.4g	+ 51-13+52-15+143-4+22

But the corresponding introspections plainly show that the disappearance of the sensation is due to distractions which forcibly claim attention. In a few cases, especially those toward the end of the observation, the organism gradually becomes adapted to the stimulus, which would, we may infer, be lost without recovery, were it not for certain involuntary tremors occurring in the hand or for slight movements in other parts of the body. Nevertheless, it is important to notice that the longest periods of absolute perceptibility in nos. 1, 2, and 4 lasted 179 sec., 136 sec., and 143 sec. respectively, which is characteristic for all other observations with the same stimuli, and undoubtedly indicates that attention was approximately constant and undisturbed during these periods.

In the case of S the few recorded fluctuations are plainly due to distractions of attention caused by such things as "finger ring pressure," "itching of hand," "twitching of an arm muscle," "ache in right shoulder;" by trains of ideas; or by external noises and disturbances. But with greater practice S learned more and more to disregard these distractions and the number of disappearances became less, being finally only 3 during an observation of 5 minutes. This means, of course, that the periods of absolute perceptibility became correspondingly longer, some of them lasting, for example, 99 sec., 110 sec., 180 sec., and 200 sec. S noticed also in his introspections that the quality of the sensation set up by the weight changes, being sometimes "a pricking sensation under the weight," sometimes warm, and toward the end slightly painful.

The results given by M were of a different nature. Finding

that the weight when put on the skin gave not only pressure, but also set up a complex of other cutaneous sensations, she attempted to abstract from them and to observe the pressure only. This required a constant analysis and often made it very difficult to decide whether pressure itself was still there or not. At such moments of doubt attention was easily drawn away to some other disturbing factor, and hence gave rise to a number of disappearances of the pressure, while nevertheless the weight could be perceived in terms of some other cutaneous sensation. This will come out in the following quotations:

Observer M. Weight 22.4g. "Numbish, unpleasant feelings; wanted to throw it off, or, sometimes, to move hand in order to see if it was still there and intensify the pressure. When no distinct pressure sensations were present, there was often a residue of vague itching or vibratory feeling, internal. On the other hand, the return of the pressure, as pressure, was always distinct, abrupt, as if weight were newly lowered on skin."

Weight 19.4g. "Disappearance twice correlated with a tingling in thumb, which seemed to swamp other sensations from hand. At other times distraction seemed to be a sensation in head, which pushed to front of consciousness. Many minor fluctuations of intensity, when the feeling was that while the sensation remained, it was temporarily blurred over, partly by the crowding in of sensations from other parts of the body, were not recorded."

Weight 13.4g. "At first easy to hold attention on pressure sensation. Got tired toward end—hard to concentrate on it again. Sensation itself attended to varies very much—pressure part seems to decrease considerably in intensity toward end. Other elements, temperature, tingling, etc., vary also from time to time. Pressing of key seems to bring pressure element abruptly back. Toward end, conscious of pressure of weight only as a vague discomfort over that area."

Weight 10.4g. "As above, very difficult to keep attention on pressure pure and simple—keeps shading off into faint tingling or glow (cold?). Toward end, sensations from weight, which had been vague and elusive for quite a period, came back when I coughed and involuntarily moved hand. These (pressure and cold) remained with hardly a fluctuation for rest of series, much clearer than in earlier part of record."

Weight 7.4g. "Blanks recorded sometimes (as above) mere lightenings and returns of the pressure sensation in its setting of surrounding cutaneous sensations. Sometimes a total shift of attention to other spheres of sensation,—distraction usually visual. Toward end the sensation reappears more as heat or dull ache than as pressure."

In order to test or check these observations, M was given another series of experiments with the same weights, but with the explicit instruction to record only the intervals when there was no indication of the presence of the weight, whether perceived as pressure or in terms of some other cutaneous sensation. The results were strikingly different, for only a few subjective distractions occurred, such as were mentioned before by her as well as by the other observers. It would be interesting to know whether Wiersma found similar phenomena in his experiments, but unfortunately he gives no introspective account

of the qualitative nature of the sensations set up by the weights, and hence it is impossible to say whether his observations are of M's kind or not. A general summary of the introspective material obtained from L, M, and S, with regard to experiments on Wiersma's weights only, agrees in all of the main points with that of the first group of observers and hence need not be repeated here. The results plainly showed that Wiersma's stimuli were by no means liminal for either L, M, or S, and hence we decided to continue the experiments with lighter weights.

For this purpose we made a new set of weights, of 6g, 5g, 4g, 3g, 2.5g, 2g, 1.5g, 1g, and .5g, with the same diameter of 1 cm. The observers were L, M, P, and S, and over 100 observations were taken. We also introduced into some experiments certain variations of procedure, by changing the stimulated area, or by shortening the period of observation from 5 to 3 minutes. These changes seemed, however, to have little appreciable effect upon the results or upon the introspective accounts.

In the case of L, for example, whose earlier results were influenced by the interfering tremors of the hand, this source of disturbance was now not strong enough to shift the weights 6g, 5g, 4g, and 3g, so that they should be perceived again after having once become imperceptible. Final disappearance, probably due to physiological adaptation or perhaps fatigue, did not take place with these weights until toward the end of the second or third minute; for example, after 96 sec., 110 sec., 112 sec., 164 sec., etc. But the lightest weights, namely, 2g, 1.5g, 1g, and .5g, disappeared during the first minute and could not be recovered, save when a considerable involuntary movement or "jar" occurred in the lower left arm. This happened twice, perhaps as the result of an uncomfortable position of the arm during the particular experiment. Introspective accounts were again demanded. They show as before that for some time after disappearance attention was extremely concentrated in an effort to recover the sensation, though without success.

The results of S are very similar to L's. The same total disappearance without recovery is here noted. But again there was not the least regularity or proportionality of the period of perceptibility to the intensity of the stimulus. The shortest period of perceptibility occurred with weight 3g, which once disappeared after 18 sec., although introspection showed that attention was maximal, while the two lightest weights could be perceived for about a whole minute. The following figures are significant, as illustrating the fact that attention could be kept approximately constant to liminal cutaneous stimuli for fairly

long periods: 94 sec. for weight .5g, 68 sec. and 78 sec. for 1g, 96 sec. for 1.5g, 84 sec. for 2g, 120 sec. for 2.5g, 112 sec. for 3g, 88 sec. for 4g, 122 sec. and 144 sec. for 5g, and 197 sec. for 6g. Again, the introspections in these experiments bring out the fact that the effort to recover the lost sensation by concentration of attention was unsuccessful, and the attempt finally given up, principally because other cutaneous sensations from the lower arm as well as the other common distractions became strong and even unpleasant.

Different results were obtained with M and P. Both observers perceived even the lightest weights during the whole period of 5 minutes. Subjective distractions, such violently intruding disturbances as "jarring of floor," or "cold and ache in fingers toward end," etc., occurred to M with irregular frequency from one to five times during 5 minutes' observation, and were of very short duration. P also mentioned the occurrence of occasional momentary diversions of attention. The difference between L's and S's results on the one hand, and M's and P's results on the other, is probably due to several factors; but the introspections of the latter observers bring out mainly two. In the first place, it was very difficult for both M and P to tell exactly whether the sensation perceived in the stimulated area arose from the weight or not. To quote from introspections:

Observer M. Weight 0.5g. "Very light weight; attention harder to maintain (first two records show complete distractions of attention). Found myself continually tending to attend to the hand as a whole and compare with normal sensations in order to decide whether weight had disappeared; always seemed to find some kind of sensation left."

Weight 1g. "Much the same as above, but I found it more definitely limited to approximate area of weight. Rarely a light contact sensation; but in first part intermittent pulsing sensation as if throbbing of arteries lifted and dropped the weight; then later, muscular tension and weight feeling, deeper and as intensive as far heavier weights."

P's observations, though less explicit on the point at issue, clearly indicate that the complex character of the light weights was not perceived simultaneously, but rather successively, changing, *e. g.*, from "a very delicate touch" to temperature, generally warm, then to pain, and lastly to a "numbish indefinite something." These "different aspects of the weight," as P himself termed them, helped him in judging the pressure of the stimulus. Nevertheless, he doubted the possibility of sensing a very light weight for 5 minutes, and said that sometimes he was not sure whether what he felt was cutaneous and just below the pressing weight, or whether it was something more deeply subcutaneous, or even at a small distance from the

stimulated spot. Since M had entirely given up the attempt to analyze the sensational complex set up by the light weights, she was less easily and less often distracted, and employed, like P, every qualitative change in the stimulation as a criterion for judging the presence of the stimulus. The fact that both M and P had great difficulty in observing the actual nature of a liminal areal pressure stimulus seems to be in line with a similar difficulty which Spindler found in determining the nature of the after-effect of areal stimulation.[1]

This article suggested to us the second principal factor involved in the difference between M's and P's results and those of L and S. Since L and S never, M and P, however, very frequently, mentioned a long lasting after-sensation, it is possible that the latter, instead of having the actual sensation from the weight, perceived only an after-sensation which might have arisen after the weight itself had become imperceptible, though still present. At least both M and P often found that even immediately after removal of the light stimulus the previous sensation persisted without changing in any way whatever. However else the difference might be accounted for, it is not further relevant to the general conclusions to be drawn from these experiments.

Summing up the results, we arrive at the following facts and conclusions:

(1) A liminal areal stimulus applied to the skin after about a minute's time loses its original character, and either disappears altogether after the lapse of another minute or two, or persists as a simple, indefinite, vague, and unpleasant irritation.

(2) It is possible for a practised observer, under most favorable circumstances, to concentrate attention for at least 2 or 3 minutes upon an areal pressure stimulus of liminal intensity without experiencing any kind of fluctuations.

(3) Qualitative changes in the cutaneous sensation itself are noticed only while, and presumably because, attention is maximal.

(4) There is a strong tendency for attention to become more and more concentrated the fainter the stimulus grows.

(5) The muscular effort involved in maximal attention to a single liminal stimulus makes concentration during a period of 5 minutes very difficult, painful, and fatiguing.

II.

In repeating Ferree's experiment with electro-cutaneous stimulation of the tongue, we found some difficulty in eliminat-

[1] After-Sensations of Touch. *Psych. Rev.*, IV, 1897, 631 ff.

ing the touch, pressure, and taste sensations set up by the electrodes. The best results were obtained by applying a 1% solution of cocaine to the fore part of the tongue, upon which 2 strips of tin foil (Christmas-tree foil), hammered as thin as possible, were laid. The strips were connected with the interrupter of a Du Bois-Reymond induction coil. Unfortunately, the number of interruptions could not be regulated or even kept constant during a single observation, because the screw by which the interrupter was adjusted tended to work loose. The cocaine itself gave rise to certain sensations; but as soon as these began to fade away the tin foil electrodes could be applied, and were generally not perceived for a long time. The movable coil was adjusted to the limen for the different observers, which was at 10 cm. above the zero point for M and G, and at 9 cm. for L. Each experiment lasted 2 minutes, after which the observers rested as long as they desired. Toward the end of the period, adaptation, or perhaps fatigue, set in and caused the sensation to disappear altogether without recovery. About 50 observations were taken with L, M, and G, during January of this year.

The results were very similar to those with the weights, and agreed with Ferree's observations. It was impossible to avoid all subjective distractions, which were principally of two kinds. First, it is very difficult to hold the tongue perfectly motionless for more than 1 minute. After this interval it was practically impossible to avoid little involuntary movements, which sometimes caused the electrodes to shift or slip off. The other kind of distraction was due to the fact that generally, after about 70 or 80 sec., the exposed part of the tongue became more or less dry, which either resulted in the entire disappearance of the stimulus or caused the electrodes to stick fast to the tongue and exert a pull strong enough to overcome the faint electrical stimulus. In spite of these difficulties, we obtained 10 fairly good observations from each of the three observers, which plainly showed that liminal electro-cutaneous stimulation of the tongue does not give rise to intermittent sensations.

Introspective accounts were demanded after each observation, whether successful or not. The condition of the tongue immediately after the application of cocaine is described in the first three of the following introspections, while the rest are typical accounts of the experiment itself:

Observer L. "Tongue feels velvety when rubbed against the teeth; also there is what might be called a vague sensation of numbness, a sense of restriction."

Observer M. "Tongue (after cocaine) feels as if it had been burned. A thick, soft layer on surface with slight sting underneath. Tender, swollen."

Observer G. "Tongue feels numb, tight, or stretched, slightly

rough, sometimes burning, sometimes cold, as if melting ice was put on it; a metallic-bitter taste remains for some time and finally fades away, leaving only a vague feeling of numbness."

Observer L. "Current always faintly felt; much attention required; tongue numb; stronger sensations at times than at others."

"Current weak; fluctuation (*i. e.*, a total disappearance without recovery) I believe due to electrodes sticking as it were to tongue which dried from exposure. During fluctuation attention was still focussed in an effort to call the sensation back." (An unsuccessful experiment.)

Observer M. "Felt current distinctly as little intermittent pokes into tongue. Less difficulty with tongue than usual, *i. e.*, less wiggling. Discovered that what had once seemed like a gap in the current was really filled with minor vibrations which seemed to require an active shift of the attention to get hold of."

Observer G. "Intensity more regular this time; in right electrode I felt the little beatings quite distinctly. Sometimes a cold, metallic taste fused with the electro-cutaneous sensations."

Here again it seems obvious that the observers were able to notice not only any shift of attention to a source of distraction, but also whether or not attention remained maximal during a disappearance of the original sensation. The fact that it did remain constant for at least 2 minutes leads us to the two-fold conclusion (1) that liminal electro-cutaneous sensations under favorable conditions do not fluctuate, and (2) that even if interruptions occur in such sensations owing to external disturbances, attention itself may remain concentrated, merely shifting its focus from the lost sensation to the intruding distraction and back again. It seems reasonable to suppose that the disturbances would not have been sufficient to distract attention if it had not been directed to a single liminal cutaneous stimulus which is very monotonous and almost indifferent as to its affective tone, but to supraliminal stimuli or, better still, to topics of greater diversity and of higher affective coloring. This is borne out by almost daily observations in actual life, such as the intensive reading of an interesting novel, listening to a piece of music, what is generally called absent-mindedness, etc. Here certainly attention remains maximal for a considerable length of time, while there is a rapid change of the mental processes occupying the focus of attention. But fuller evidences of this fact are greatly needed, and must be obtained by a more systematic appeal to introspection with this particular end in view. That our own introspective records are not sufficiently explicit in this regard is due first to the fact that our observers tended rather to justify occurring distractions than to emphasize the periods when attention was absolutely concentrated upon the stimulus; and secondly to the fact that the stimulus set up a complex of sensations which they were eager to analyze and describe. Nevertheless, our final conclusion must be that under favorable circumstances attention focussed

upon liminal and supraliminal cutaneous sensations remains approximately constant for at least 2 to 3 minutes, provided that physiological adaptation of the sense-organ and violently intruding distractions can be avoided for this length of time. The normal course of events is that the sensation, once set up-fades out steadily and gradually in consequence of adaptation.

A QUICK METHOD FOR DETERMINING THE INDEX OF CORRELATION.

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The desirability of substituting an accurate numerical index for mere verbal expressions of correlation has been very clearly set forth by Galton, Pearson, Yule, Spearman, Wissler, and other writers.[1] But the most accurate formula, the 'product-moments' formula of Pearson, is attended with arduous labor. We may greatly abridge the numerical work by the use of an adding machine[2] and of appropriate tables, such as Barlow's *Table of Squares*, and Krelle's *Multiplication Tables*. Further, the computation of σ, the standard deviation, may often be reduced by considering it as equal to *m. v.*, or the average deviation, times the constant, 1.2533. Yet, even so, the task is considerable, so that, particularly if one has to determine a number of correlations, it is desirable to use a shorter method for preliminary exploration.

A number of shorter correlation methods have been described.[3] It is the purpose of the present article to describe a simplification of one of these methods that the writer has found very expeditious and serviceable for the determination of an approximate numerical correlation. This method is based upon the use of what is known as Sheppard's formula, which may itself be regarded as a simplification of one of Pearson's auxiliary methods.

For the application of this, as of most formulas, the data of

[1]See, for instance, F. Galton, *Natural Inheritance;* C. Spearman, The Proof and Measurement of Association Between Two Things, this *Journal*, XV, 1904, 72; C. Wissler, The Correlation of Mental and Physical Tests, *Psych. Rev. Mon. Supp.* No. 16, 1901. The important contributions of K. Pearson, and R. Yule, will be found in the *Proc. Royal Soc.* of London, in the *Phil. Transactions* of the same body, the *Jour. Royal Stat. Soc.*, and, in their more recent applications to biological problems, in the several volumes of the *Biometrika*, 1901 ff.

[2]An inexpensive, but very serviceable device, known as the Gem Adder, is now put on the market by the Automatic Adding Machine Company, Broome St., New York City, at a price of fifteen dollars, and is well worth purchase by any one who contemplates correlation work.

[3]See, for example, the articles by Spearman and Wissler.

each of the two series to be compared must first be distributed in an orderly array. Suppose, to take a concrete instance, we wish to ascertain the correlation between the accuracy with which 50 boys cancel *e* from a printed slip and the accuracy with which the same 50 boys cancel *q*, *r*, *s* and *t* from a similar slip. The results of each test are first arranged in order, the least accurate boy first and the most accurate last. We can then either determine the average, in which case all the boys that rank below the average are minus and all that rank above are plus, or we can simply take the median value and consider the first 25 boys in each array as minus, and the second 25 as plus, cases. By rapid comparison the following values are next determined:

a =	no.	cases	that	are	plus	in	the	1st	and	plus	in	the	2d	series.
b =	"	"	"	"	plus	"	"	"	"	minus	"	"	"	"
c =	"	"	"	"	minus	"	"	"	"	plus	"	"	"	"
d =	"	"	"	"	minus	"	"	"	"	minus	"	"	"	"

The index of correlation may now be obtained by reference to one of Pearson's simpler formulas:

$$r = \sin \frac{\pi}{2} \frac{\sqrt{ad} - \sqrt{bc}}{\sqrt{ad} + \sqrt{bc}}$$

Now this formula may be brought into a more convenient form if we replace the sine by the cosine of its complement.

$$r = \cos \left[\frac{\pi}{2} - \frac{\pi}{2} \frac{\sqrt{ad} - \sqrt{bc}}{\sqrt{ad} + \sqrt{bc}} \right]$$

when we can reduce to

$$r = \cos \frac{\sqrt{bc}}{\sqrt{ad} + \sqrt{bc}} \pi.$$

If, now, we further simplify by substituting for the square root of the product of the *b* and *c* cases the percentage of cases with unlike signs (U), and for the square root of the product of the *a* and *d* cases the percentage of cases with like signs (L),[1] we obtain Sheppard's formula:

$$r = \cos \frac{U}{L + U} \pi$$

The results of this formula do not differ appreciably from the foregoing as the value of the fraction is virtually identical.

[1] That is, virtually, substituting the arithmetical for the geometrical mean.

Now, since L + U must always equal 100, and since $\pi = 180°$, this formula may be written for greater convenience,

$$r = \cos U\ 1.8°$$

Finally, since the values of U must range from 50 to 0 for positive, and from 50 to 100 for inverse correlations, it now becomes possible to prepare a simple table from which the values of r for any integer value of U may be read directly, and I have here introduced this Table in the hope that it may prove of interest and assistance.

Correlation Table.

for the formula $r = \cos U\ 1.8°$

If U is greater than 50, first substract it from 100, then prefix the minus sign to the correlation indicated.

U	r	U	r	U	r	U	r	U	r
0	1.000	10	.951	20	.809	30	.587	40	.309
1	.999	11	.941	21	.790	31	.562	41	.279
2	.998	12	.929	22	.770	32	.536	42	.248
3	.995	13	.917	23	.750	33	.509	43	.218
4	.992	14	.904	24	.728	34	.482	44	.187
5	.987	15	.891	25	.707	35	.454	45	.156
6	.982	16	.876	26	.684	36	.426	46	.125
7	.976	17	.860	27	.661	37	.397	47	.094
8	.968	18	.844	28	.637	38	.368	48	.062
9	.960	19	.827	29	.613	39	.338	49	.031

It will be seen, then, that the discovery of the approximate numerical value of the correlation between two series of data is reduced to four simple steps, (1) distribution of the data into two arrays sectioned at the median, (2) counting the cases with unlike signs and (3) dividing this number by the total number of cases, (4) reference to the Table.

The probable error may be calculated from the formula:[1]

$$p.\ e. = \sin\left[0.1686\ \pi\ (1 - r^2)\sqrt{\frac{1}{a} + \frac{1}{b} + \frac{1}{c} + \frac{1}{d}}\right]$$

To illustrate the employment of these methods, in the example cited the following values were obtained: $a = 18$, $b = 11$, $c = 8$, $d = 13$. Hence $U = 38$. By the use of either short formula, $r = +.37$ with p. e. $= .26$. By the use of Pearson's product-moments method we obtain for the same arrays, $r = .47$, with $p.\ e. = .06$, but, by actual timing, after the distributions had been made the first method occupied eight minutes

[1] The value of $(1-r^2)$ for all values of r may be obtained directly from a Table published by Yule, *Jour. R. S. Soc.*, X., 1897, 852-3.

and the second two hours and fifteen minutes, even with the aid of the adding machine and the Tables previously mentioned.

The short method cannot, of course, be recommended for the final determination of important correlations, because the probable error is large, particularly with relatively few cases and a low value of r, but it is very serviceable for the preliminary examination of such data, and may give results of value when the scale divisions are fairly fine, the data symmetrically distributed, the number of cases not too small, and the correlation large, say above 0.50.

SOME EXPERIMENTS ON THE ASSOCIATIVE POWER OF SMELLS.

By E. M. Bolger and E. B. Titchener.

This brief communication may be regarded as a foot-note to the study published under the same title in 1905 by the Misses A. Heywood and H. A. Vortriede.[1] The object of that study was to make a laboratory test of the observation, not uncommon in everyday life, that odors possess a remarkable power to revive past experiences. The method followed was, in general, that used by Professor Calkins in her work on association. Combined series of odors and pictures, and of odors and colored squares, were presented to the observer, and the series of odors repeated later in a different order; the percentages of correct associations were then noted. The results were checked by those of series in which the odors were replaced by nonsense syllables (auditory stimulus). The authors conclude that "the odors have no superiority in suggestive or associative power over the nonsense syllables."

It seemed to us that it was worth while to repeat these observations. We hoped, on the one hand, to go a little more deeply into the qualitative analysis of association, and on the other to get suggestions for an improved method of attacking the problem. Both efforts were unsuccessful. The Calkins method is, without any doubt, too crude for analytical work, and the change that we ourselves introduced led only to negative results.

We first repeated the Vassar experiments, with two minor variations. The time of exposure was reduced from 15 to 5 sec., on the ground that a time of 15 sec. might give opportunity for wandering of the attention. Secondly, while we employed the 6-term series with one observer, we raised the number of terms to 12 for two other observers: it was possible, we thought, that the odors might show their superiority under the more complicated conditions. The results need not be given in detail. They resembled those obtained in the Vassar laboratory, except that the odors showed at a still greater disadvantage. It was clear that, under the conditions of these ex-

[1] Minor Studies from the Psychological Laboratory of Vassar College, communicated by M. F. Washburn, i. This *Journal*, XVI, 1905, 527; XVII, 1906, 148.

periments, an exposure time of 5 sec. does not allow an odor to impress itself upon the attention.

We then had recourse to a change of method. The odors that in everyday life prove effective for recall are diffused odors; the "smell of box" that "recalls a garden frequented in childhood" was probably dominant over a wide area of the garden, and was thus associated to a varied and complex visual situation. We tried to reproduce this condition by suffusing our pictures with odors, instead of presenting the odors separately in phials. A careful selection was made of 50 picture postcards. Envelopes, filled with cotton wool, were pasted to the backs of the cards; and the wool was saturated with the odorous stimulus before the experimental series began. The odors were distributed, as evenly as possible, over Zwaardemaker's nine classes. Every care was taken to keep the stimuli from mixing or becoming contaminated during the course of the tests. The cards were arranged in 5 series of 10 members, and the experiments were made with two observers, both of whom had taken part in the previous work. The time of exposure was 10 sec. for the one and 1·5 sec. for the other observer.

The stimulus in the combined series was now a scented picture; in the test series, the scent alone. Nevertheless, although the conditions were by so much nearer the conditions of everyday life, the outcome was still negative. The odors were no more effective than nonsense syllables (auditory stimulus), and were distinctly less effective than simple geometrical figures drawn with ink in a corner of the pictures. The result was the same for both observers, and therefore for both exposure times.

The next step in method would be, perhaps, to make up combined series of a mixed sort,—one or two of the pictures being scented, and the rest paired with nonsense syllables or colors or geometrical forms. We were, however, compelled to break off the investigation at this point.

GENERAL PRACTICE EFFECT OF SPECIAL EXERCISE.

By J. E. Coover and Frank Angell.

Somewhere in the course of a lecture on the Relation of Natural Science to General Science, Helmholtz speaks of the advantages possessed by certain studies as "means for training the intellect, inasmuch as they tax equally all the intellectual powers," and this belief in the general disciplinary value of certain studies,—the greater or less efficacy of certain kinds of intellectual work as mental gymnastic—probably forms the *raison d'être* for education in the minds, not only of most laymen, but perhaps of most teachers of the present time, though what may be the factors entering into this disciplinary process is a question which usually receives a broad or vague answer. But of late years, under the title of formal discipline, the tenet has lost considerably in dogmatism and gained somewhat in definition, so that it has become a subject for experimental investigation. The present article is a contribution to this aspect of the subject, *i. e.*, whether it can be shown by direct experiment that the improvement acquired by practice in one kind of mental activity is induced in some other kind, more or less remote.

The greater part of the literature of the subject has been too frequently thrashed out to need further mention here. Of the less commonly quoted, articles which bear directly on the question may be cited, 1st, Urbantschisch's investigation in *Pflü. Arch.* Bd. 42, in which he showed that the influence of a sound stimulus is to lower the limens for light, smell, taste and dermal sensations; 2nd, Epstein's work, published in *Zeit. f. Biol.* Bd. 33, indicating that a sound stimulus heightens visual acuteness and sensitiveness to color, and 3rd, Vogt's research on Distractibility and Habituation in Kraepelin's *Psy. Arb.* Bd. 3, demonstrating that habituation to a distraction acquired in one exercise may be carried over to other exercises. There remain, however, two investigations, which, being of more recent date, have passed less frequently through the critical mill and therefore call for more detailed examination; Ebert and Meumann's extended research on certain fundamental questions connected with memory practice in *Arch. f. d. ges. Psy.*, Bd. 4, and Thorndike and Woodworth's work on the "Influence of Improvement in One Mental Function upon the

Efficiency of other Functions," in Vol. 8 of the *Psy. Review*. The treatise of Ebert and Meumann is an investigation of the induced effects of one kind of memory training on other kinds of memory carried out according to the "test" method. More especially, "a cross section" of memory was taken, determining the efficiency of the several memories for meaningless syllables, letters and numbers, one-syllabled substantives, foreign words (Italian), stanzas of poetry, visual signs, and prose. The reagents were then trained on meaningless syllables, when another "cross section" of memory was taken, to test both immediate and permanent retention. The tests indicated that the special training had increased the efficiency of all the several kinds of memory and that for the kinds of memory most closely allied to the test processes, the increase in efficiency was greatest. Thus, the authors state that the training increased the efficiency of memory for retaining philosophic prose 70%, and the memory for visual signs—a process certainly very unlike the training process with meaningless syllables—showed an increase in efficiency of over 55%, (*Arch. f. d. ges. Psy.*, 4: 182). In fact the increase in memorizing ability for all kinds of memories was so great that the reagents came to designate the training process as "memory cure." It is to be regretted that the authors did not carry on a "control" experiment along with their tests to ascertain the training effect of the tests themselves and to throw additional light on the changes taking place in the training intervals. Nevertheless, the investigation indicates pretty clearly that the training of a special memory increases the power of memory in general. The answer to the question how the learning of meaningless syllables increases the efficiency of all other kinds of memory is answered by the authors with an explanation involving a sympathetic practice effect of allied memory functions through a hypothetical psychophysical action. But as G. E. Müller has pointed out in his review of the work (*Zeit. f. Psy.*, 39: 113), the known causes of improvement, regarded by the authors as merely auxiliary, such as increase of power of concentrating attention, increase in effort to perfect a memory, decrease in feelings of discomfort and tediousness, improvement of technique of learning—all of these should be logically regarded as "cause" rather than a mysteriously hypothetical psychological action.

The investigation of Thorndike and Woodworth was also carried out according to the test method, its object being to ascertain the result of training with weights, areas, and lengths on the ability to estimate other weights, areas and lengths respectively, that differed from the training series either in size or shape or both. In addition they tested the effect of training, in the marking out of certain letters or misspelled words on a

printed page. One misses, however, those qualities which make Ebert and Meumann's investigation of first rate importance, particularly the careful elaboration of the plan of work, the actual working out of the method in the form of detailed introspections, and the searching and thorough analysis of results. The general conclusions from these experiments are given in Thorndike's "Educational Psychology," p. 91, and are to the effect that "the improvement in any single mental function need not improve the ability in functions commonly called by the same name," and further that "the practice effect seems to make it likely that spread of practice occurs only where identical elements are concerned." It does not appear that the conclusions of the authors of the article are wholly borne out by the figures, the test on estimating the size of surfaces, *e. g.*, showing greater improvement for figures which were unlike the training series in size and shape than for those nearest in either size or shape. The writers state that their experiments were rough and designed to show merely general tendencies, but it is not clear that the figures show anything beyond great individual differences. Had the figures shown a loss of efficiency in executing the tests, the question of transference of function would have still been open. Rough experiments unaccompanied with introspection and so not susceptible of careful analysis are of very little value in work of this kind. The marking out of words is a complicated discriminative reaction, which is not only performed in very different ways by different reagents, but in different ways by the same reagent in one sitting. How different these ways may be will be shown later in an analytical paper by Mr. G. Snow-Gibbs on "Tests in Applied Psychology." On the other hand introspective data gathered by one of the present writers in repeating these experiments (J. E. C.) seem to indicate clearly that the improvement in after tests in marking out letters is not due to the functioning of "identical motor elements," viz., eye movements for example, but to a reduction of the recognition of a word as containing certain letters to its essential process. The process had been relieved of the unnecessary and retarding accompaniments (kinæsthetic and acoustic imagery) noted in the first tests and in the early stages of training. In other words the improvement was due to the general function known as habituation.

At any rate it seemed advisable to attack the problem in such a way that the factor of identical motor elements could play no important part, so that if improvement in efficiency was shown in the test, it could only be attributed to some such general factor as habituation. Accordingly tests were made on sensible discrimination in different modalities of sense and on

discriminative reaction with choice in which the reaction motions common to the test and training series were a negligible quantity. In addition, control experiments were carried along to indicate the effects of test series without the training.

I. Test in Light Discrimination with Training in Sound.

Four reagents were trained in discrimination of intensities of *sound* for 17 days during an interval of 57 days. Each reagent made 40 judgments in each day's training.

Before and after training the reagents were tested in the discrimination of shades of gray, each test consisting of three series, each containing 35 judgments, delivered on 3 separate days.

In the training on sound the stimuli were given with a sound pendulum. The method was that of constant difference, procedure being without knowledge, There were about 10 values for D in each series. The judgments were made in four categories, viz., louder, softer, like, and doubtful. In one pair of series each day, introspections were noted down by the reagent after each judgment; in the remainder the noting of introspections was reserved until after each series was finished.

Discriminative ability at the beginning and end of the training was calculated in per cents of Right cases in the first ten judgments and the last ten judgments made upon six each of the values of D, that is, upon most of the judgments of the first and last two days. No judgments were included where D=0, and "like" judgments for other values of D were regarded as undecided.[1]

The tests on brightness were made with a Marbe color mixer so mounted as to run noiselessly. The experiments took place in a dark room with the light coming from behind the reagents. All the apparatus, including the disk when not exposed, was draped in black. Norm and variable were exposed for two seconds with an interval of four seconds. The attention signal came two seconds before the exposure of the norm. The method was also that of constant differences, without knowledge and the judgments were given in the categories of "lighter," "darker," "like," and "undecided." Introspections were noted by reagents after each series of seven judgments. The order of variables in the test before training was repeated in the after-training test, but in both cases was believed by the reagents to be determined by chance. In order to estimate the possible practice effects of the preliminary test

[1] F. Angell: Discrimination of Shades of Gray, etc. *Phil. Stud.*, XIX, S. 20.

and the interval between that and the after-test, a control experiment was carried along. In this three reagents were given tests in brightness discrimination under conditions identical with those obtaining with the regular reagents, except that 2 instead of 3 days were taken as a basis of comparison. At the end of the interval used by the test reagents for training, *i. e.*, 46 days, the control regents took the second test.

Table I gives a summary of the numerical results for both test and control reagents. From this it will be seen that all the test reagents with one exception show a gain in Right and loss in Undecided judgments after training, and that all the control reagents show a loss in discriminative ability after the interval of rest which was occupied by the test reagents in training. The per cent. of gain for the 4 test reagents was 4, 4, 6, 6, 0, 0, and 27, 5, making an average of 9, 1. The case of the one test reagent who showed no improvement in the after test would seem to be a fair example of the exception which proves the rule, for while the other reagents in the training on sound all showed improvement which amounted to 7, 5, and 15 per cent. respectively, this particular reagent showed no improvement in the judgments of the last two days as compared with the first two, and in fact had fallen off to the extent of three per cent.

The introspections indicate that the discrimination processes were accompanied by much imagery from other domains of sense which in some cases determined the judgment. This imagery was in great part kinesthetic and visual. In addition the sounds seemed to have certain spatial or temporal attributes which at times influenced the judgments. "Variable had a long drawn out sound;" "Variable is a broader sound, that is to say, widely spread;" "Variable comes from a farther place;" "Variable is a small sound." Again bodily impressions may have entered into the act of comparison such as "resonance" or "ringing" in the ears or seemingly deeper seated sensation in the head. "Discriminate effects in the head rather than external sounds." One reagent seemed to compare the intensities of bodily reactions to the sound stimuli themselves or to imagery called up by the stimuli, *e. g.*, the "flash of a bicycle lamp."

Besides these various reproductive factors which accompany the essential sound-discrimination process, there are disturbing factors of a general nature, such as strong expectation for a loud or weak sound, and the varying intensity of the state of attention. If a loud sound is strongly expected, a weak one may seem weaker; if a weak one is expected a loud one may seem louder. If the intensity of the state of attention is sought to be kept at a maximum, it will vary greatly, a result

TABLE I.

Comparison of Test and Training Judgments for Test Reagents and of Test Judgments for Control Reagents.

Test Reagents.

A.	Right Judgments.	Aw	Na	Ya	Cr	Total.
Tests.	No. R. Before training.	60	46	47	46	119
	" " After "	64	52	47	68	231
	Diff.	+4	+6	0	+22	+32
Training in sound.	No. R. 1st 2 days.	22	22	26	27	97
	" " last 2 days.	31	25	24	34	114
	Difference.	+9	+3	−2	+7	+17
B.	Undecided Judgments.					
Tests.	No. U. Before training.	16	38	22	27	103
	" " After "	13	19	28	6	66
	Difference.	−3	−19	+6	−21	−37
Training in sound.	No. U. 1st 2 days.	18	23	16	16	73
	" " last 2 days.	9	16	20	8	53
	Difference.	−9	−7	+4	−8	−20

Control Reagents.

C.	R. and U. Judgments.	Rl	An	Wr		Total.
Tests before and after interval without training.	No. R. Before interval.	41	31	46		118
	" " After "	38	30	43		111
	Difference.	−3	−1	−3		−7
	No. U. Before interval.	10	16	2		28
	" " After "	13	15	7		35
	Difference.	+3	−1	+5		+7

due both to its own rhythm and to the varying subjective conditions upon which it depends.

Improvement seems to consist of divesting the essential process of the unessential factors, freeing judgments from illusions, to which the unnecessary and often fantastic imagery gives rise, and of obtaining a uniform state of attention which is less than a maximum: "Judgment does not require strained attention. All are quite certain or satisfactory. Don't see what the process is now—seems automatic" (Cr. May 12, IV). And uni-

formity of direction of attention may also result: "Am able to abstract from visual image of the apparatus entirely, and yet refer the sounds to external stimuli. This seems to take the least effort and is more satisfactory" (Cr. May 17, IV). Many of the introspections of the various reagents, near the end of training, were "No imagery."

Our conclusion from the experiment, therefore, is that efficiency of sensible discrimination acquired by training with sound stimuli has been transferred to the efficiency of discriminating brightness stimuli, and that the factors in this transfer are due in great part to habituation and to a more economic adaptation of attention, *i. e.*, are general rather than special in character.

II. Reaction with Discrimination and Choice.

In the experiments with discrimination and choice identical motor elements were eliminated by employing different kinds of stimuli and different forms of reaction, although in both cases the sense of sight received the stimuli, and reactions were made by movements of the hands.

The object of the experiment was to determine the effects of practice in one form of activity upon efficiency in another. This influence could show itself either in lowering reaction time in the latter, or making it more regular, or both,—which would be apparent in a practice curve of the tested ability.

The training was accomplished by about 15 exercises in sorting cards. Four reagents took the training which was scattered through a space of about 40 days. In this time about 4,000 cards were distributed by each reagent (Cl 4,200, Al 3,800, Cr 5,200, Bs 4,000).

Before the training in card-sorting the reagents were tested for five days on "typewriter reactions," aggregating about 3,000 reactions in each case (Cl 2,900, Al 2,900, Cr 2,700, Bs 3,100), and after training in card-sorting there came the after test for three days, giving about 1,800 reactions (Cl, Al, Cr, 1,800, Bs 1,700).

For the training a Jastrow card-sorting cabinet was used with 6 compartments; the cards were made of smooth, buff-colored Bristol-board (77x52 millimeters). In the centre of each card a colored rectangle was painted in water color (12x 52 mm.), six colors being used—red, blue, black, and brown in a rather deep shade, and yellow and green in tints. The cabinet stood at a convenient height, and was entirely covered with black cloth.

In card-sorting the reagent stood at the cabinet and held in his left hand a pack of 50 cards, from the top of which he would grasp a card, turn it up sufficiently to see its color on

the under surface and drop it into its appropriate compartment. In about the middle of the training the color labels were removed from the compartments.

The cards were arranged in packs of 50, according to 12 different orders in which each color appeared about as often as every other, each preceding and succeeding the other about equally often; no color recurred with less than two intervening colors.

The assignment of colors to the compartments was so made that the spatial relations of the latter would not correspond with the complementary or spectral relations of the former.

For the "typewriter-reaction" a Blickensderfer typewriter was used, fitted up with a screen through which but one letter could appear at a time. Series of letters were printed with the typewriter and cut into strips which could be clipped to the "scale-bar" and moved behind the screen by the "carriage." The spacing of the letters in the series and of the typewriter "action" being the same, the strip could be so adjusted that every time a key was struck, a new letter appeared through the screen.

The various series were made up of four letters in such a way that all the letters appeared about the same number of times, and each letter preceded and succeeded every other letter and itself about equally often.

In the "typewriter-reaction" the reagent sat with his hands in position over the lower bank of keys on either side of the middle, and reacted to the letters as they appeared through the screen—*a* and *t* on the left and *e* and *n* on the right.

The time of reaction to each letter was recorded in another room upon a kymograph. The typewriter itself, of course, making records of the reactions, which could be inspected for accuracy.

Control Experiment. In order to determine more definitely the possible effects of the training in card sorting in the "typewriter-reactions," three reagents were trained in the "typewriter reaction" three days before and two days after an interval of 45 days during which no training was taken. In both the test and control experiment, efficiency was estimated by the time involved and in number of errors in each 100 reactions.

Table II gives the daily average time and error for 100 reactions on the typewriter for the test reagents, both before (A) and after (B) training in card-sorting, and Table III gives like data for the control reagents, both before (A) and after (B) an interval without practice.

The quantitative results as laid down in those two summaries seem to be ambiguous: the reagents trained on the card-sorting show indeed an increase in efficiency in the after-test on the

TABLE II.

Test Reagents. Daily average of time (in sec.) and errors for 100 reactions on Typewriter.

A. Before Training.

Cl		Al		Cr		Bs	
sec.	errors.	sec.	errors.	sec.	errors.	sec.	errors.
71	2	94	0	73	3	99·5	5
76	0.9	93	4	76	3	87·3	3
73·5	1.1	80	3	71.2	3·5	84	4·5
67·4	1	73.1	6.3	69.1	3	80.1	5·3
69	1	72.2	4·5	69.1	5	77·9	4·3
63·3	0.8	72.7	7	67	4		

B. After Training.

63.1	1	65.2	8	66.4	4·5	70.7	8
61.3	1	62.9	11	62.1	4·5	69	3·3
60.4	1	61	13	61.7	5·4	66.3	6

TABLE III.

Control Reagents. Daily average of time (in sec.) and errors for 100 reactions on Typewriter.

A. Before Interval.

sec.	errors.	sec.	errors.	sec.	errors.
90.7	5	141.8	4	87	1
74.1	7·5	116.5	1.3		
74	6.3	96.1	1.5		

B. After Interval.

70.7	4·5	90.5	1.3	80.5	1
66.2	7	86.2	1.3		

typewriter, but most of them show an increase in errors. Moreover the control reagents also show an increase in efficiency after their incubation period. In both cases, however, an increase in speed was to be expected, for the common belief in beneficial effects of incubation periods on bodily activity has been amply confirmed by numerous investigations on practice and fatigue. The question of the effects of the training in card-sorting must, therefore, find its answer in an examination of the errors and of the introspective evidence. The obvious explanation of the increase in speed accompanying the decrease in accuracy is that as the reagents increased in manual dexter-

ity they became more careless in co-ordinating the visual impressions with the reactions; in short, that accuracy was sacrificed to speed. But a study of the errors shows that the obvious explanation is not correct, for taking from each of the eight test days the series of reactions showing the maximum and minimum number of reactions respectively, we get

TABLE IV.

Table of Relation of Reaction Times to Max. and Min. Number of Errors.

Cl	with	0,06	errors	averages	66,4	sec.	for	100	reactions
	"	2,3	"	"	67,9	"	"	"	"
Al	"	4,7	"	"	72,0	"	"	"	"
	"	9,9	"	"	73,0	"	"	"	"
Cr	"	1,4	"	"	65,6	"	"	"	"
	"	5,9	"	"	68,4	"	"	"	"
Bs	"	2,3	"	"	77,8	"	"	"	"
	"	7,9	"	"	81,6	"	"	"	"

The figures from which these averages are taken occur irregularly throughout the several series of the eight days, so that it cannot be urged that the correlation of a smaller number of errors with greater speed is due to each day's practice effects. As a matter of fact in the majority of the eight cases, the maximum number of errors occurred in the later series of the day. The introspections show the reasons for this inverse relation existing between speed and error tendencies. Cr notes "Made mistake and was bothered thereby;" "Errors result in confusion and pauses." Al remarks, "The large number of mistakes impedes the rapidity as one is troubled by them;" Bs says "Mistakes were noticed and caused confusion at the time." Cl says "The time I spent in thinking of a mistake caused a delay." From both tables and introspections we see that the increase of errors in the after test can be due only in a small part to carelessness accompanying greater skill in manipulation, and the question then arises, to what is it due?

There were probably at least five special causes for the errors: (1) Lack of co-ordination between the letter and its proper reaction, (2) Anticipation of a letter, in which case the reaction took place before the letter was cognized, (3) False recognition of the letter, (4) Reaction incited by rhythm without cognition of letter, and(5) Misplacement of the fingers on the keys. The fourth cause is probably the chief factor in the increase of errors in the second training.

As the reagents acquired more and more skill on the typewriter, a strong tendency developed towards rhythmic series reactions which resulted not in false or mistaken reactions, but

in mechanical reactions; that is, the rhythmic tendency was strong enough to overcome the voluntary effort towards a discriminative reaction. The effect of this power was to produce the confusion referred to above and in general to lengthen the total time for the series. A general source of error for the after-tests was the fact that they came in the closing days of the semester when the burden of the examination period fell heavily on instructors and students alike. The introspections give altogether too full evidence of the condition of general fatigue with which the reagents entered on the tests after training.

There remains to be discussed one effect of the training which cannot be shown by tables, and that is the effect of training on ease of accomplishment. The figures for the after-test on the typewriter show that the test reagents made very little gain in speed for the three days of the test itself. Indeed the skilled reagents Cl and Cr had arrived at their maximum efficiency one or two practice days before the training period, and if the card-sorting had favorably affected the speed of the typewriting it could not be shown by numerical results. But the introspections show a very unexpected increase in the ease of accomplishment following on the card-sorting.

On the first day of the second test Cl remarks, "Sight of letter produced the reaction movement without my thinking of my fingers or of the sight of the keys." Al remarked, "No headache, no nausea as before card-sorting," "Much easier than at first;" "General background of feeling is probably not unlike that of the card-sorting test, but I did not think of the card-sorting test during the trial." Cr said: "Process was surprisingly automatic and was accompanied with ease," "Seems more automatic than ever before, and even more so than the card-sorting. I do not pay the slightest attention to the fingers on the keyboard when the process is going best. . . . It appears that the old associations have not only not been interfered with by forming new ones in card-sorting, but that they have become firmer and action upon them more ready and automatic than it was before or than it was in card-sorting" (April 27). On the last day of the typewriter training before card-sorting began, Bs remarked, "Pauses between letters caused by having to think which finger I should put down," and on the first day of training after card-sorting, "Seemed more natural than I thought it would," and the next day, "Seemed more natural to react to-day, demands less attention, tendency to become automatic."

The introspections of the Control reagents, on the other hand, none of whom was familiar with typewriting, show that while some ease and facility were experienced in the period be-

fore training, the after-test seemed unexpectedly "difficult" and "unhandy;" Mn stated in the after-test that "Reacting seemed difficult," "Seemed to have to stop to think which finger was to react to the different letters." Ge in the period before training said, "The reactions are becoming more automatic;" and in the after-test that he "looked at a letter not knowing what to do," and that "combinations of letters here were particularly unhandy." Feelings of discomfort and difficulty following on the interval without practice of any kind emphasize the conclusions of the preceding paragraph, viz.: That the training in card-sorting is the cause of the increased ease and facility experienced by the regular reagents in the second trial in typewriter-reaction.

Conclusion. We may conclude, therefore, from the results of this experiment, that training the activity of Reaction with Discrimination and Choice by sorting cards into compartments has increased the facility of a like activity in both speed and regularity in "typewriter-reaction" (a) noticeably, in two cases, after the latter had become automatic, and (b) markedly in two others, in the course of practice.

The cause of transferred facility could not have been identical motor elements. In the "typewriter-reaction" the eyes rested sharply fixed upon one spot upon the screen, while in the card-sorting reaction the eyes moved rapidly about over the compartments in the cabinet, merely glancing at the colors. The differences in manipulation between tapping keys with forefingers and sorting cards are, of course, patent. To what, then, is this improvement due?

According to the introspections of the regular reagents on their card-sorting training, the process of reaction is variable. At the beginning of training they matched the color of the cards with the labels on the compartments; then to increase speed a system of mnemonics is employed, designed to form associations in the mind between a compartment and its color; this system then goes through a process of mutation,—becoming abbreviated, changed in part, supplemented, or is superseded by another; finally, through repetition, reactions to particular compartments become co-ordinated with their respective colors and are made directly—free from any "system" except in rare cases. Synchronously with the growth of these co-ordinations adventitious processes, such as pronouncing the name of the color when cognized, movements of the whole body and useless movements of the hand, decrease to a minimum.

As regards the "typewriter-reactions," the introspections of both regular and control reagents show that the processes of reaction go through like stages, except that the mnemonic

systems arise sooner and change oftener. No two systems are alike. But all finally give way to the direct reaction which has been co-ordinated with its letter. Again, adventitious processes, such as pronouncing letters upon cognizing them, visualizing keys, fingers, or their order, likewise decrease to a minimum.

Different as the typewriting and card-sorting reactions are in details the course of experimentation developed a general condition common to both, *i. e., the habit of stripping the essential process of unnecessary and complicating accessories.*

Introspections further show that in any one series several systems of mnemonics may be operative; there may be also some direct reactions due to the co-ordination of stimulus and reaction; in one part of the series one stimulus causes difficulty and elsewhere another stimulus, while some stimuli seem harder than others throughout the whole series. Improvement here seems to consist in resolving the reaction process to a single type (except in so far as reactions become direct), and in attending more closely to difficult stimuli until their reactions become as ready as those to the other stimuli.

Again, introspections and records show that, even after a mnemonic system has been successfully applied and has served to bring stimulus and reaction to a fair degree of co-ordination, lapses of attention occur during which the "mind is a blank," and the drum records abnormally long reactions. Improvement here consists in keeping attention upon the matter in hand so constantly that the irrelevant stimuli are unnoticed.

We find, therefore, the causes of the transference of facility to be: (a) the formation of a habit of reacting directly to a stimulus without useless kinesthetic, acoustic, and motor accompaniments of recognition, which results in (b) an equitable distribution of attention to the various possible reactions so as to be about equally prepared for all; and (c) the consequent power of concentrating the attention throughout the whole series without distraction.

GUSTATORY AUDITION; A HITHERTO UNDESCRIBED VARIETY OF SYNÆSTHESIA.

By ARTHUR H. PIERCE, Smith College.

During the lifetime of this *Journal* there have appeared on its pages a goodly number of cases presenting one or another of the various forms of synæsthesia. While such accounts do not yield any facts of profound import for psychology, they do yet have their distinct value in impressing us with the myriadfold divergencies of human nature, and it is just for this purpose of contributing to the 'varieties' of mental experience that the following case is presented. As far as I can ascertain, its peculiar variety is new in the annals of synæsthesia. Its singularity consists, I may say at once, in the experiencing of gustatory qualities following upon the hearing of words spoken by the human voice, or of musical and other non-vocal sounds.

As it stands, however, the statement just made is by no means a correct description of the case. Perhaps the best way of putting the matter would be to say that the word 'gustatory' must here be taken in a very wide sense as referring to all the possible experiences that the sense organs of the mouth can give. To speak with full accuracy one must say that a 'mouth-experience' of one sort or another is the accompaniment of certain auditory impressions. These 'mouth-experiences' include the four taste qualities, the cutaneous qualities of pressure and temperature, and such tactual-motor qualities as find their expression in designations of texture, consistency, and the like. Now it is only because we have no single adjective by which we commonly describe this variety of possible mouth-experiences that the word 'gustatory' is here used with the latitude indicated. Its use enables us to avoid an uncouth terminology, and with the explanation given no obscurities are likely to arise. One further fact should be added. Olfactory qualities are entirely absent from the synæsthesia, and we are concerned, therefore, with pure 'mouth-experiences' without any of those numerous fusions which popularly pass for 'tastes.'

Hitherto we have had descriptions, plentiful enough along certain lines, of colored sounds, odors, tastes and temperatures, and of total pain, pressure, and temperature. But I am not

aware that we possess any records recounting the type that I have just indicated.

I.

The subject of the case in question is a young woman, now about to graduate from college, who, as far as she can tell, has always had these experiences, the fact that they were peculiar to herself first coming to notice about four years ago. Since that time their number and definiteness have somewhat increased, owing to the numerous questions put to her by her companions as to the 'taste' of this or that name or word. But though the experiences have increased in number, I am convinced that they have not lost their original naïve character, as the facts to be cited will, I hope, show. The case has been under my observation for somewhat over two years.

Two sense defects of the subject should be noted. First, there is a slight deafness, or slowness of hearing, which becomes more pronounced at some times than at others. Secondly the subject is anosmic. No rigid tests have ever been made to determine whether the sense of smell is entirely wanting, but medical examination directed to the sense of hearing revealed a thickened mucous membrane of diminished sensitiveness, and the subject herself believes that her anosmia is complete. Coffee burning upon a stove is not noticed, though she may be close by. Camphor placed in the nostrils gives only a stinging sensation. Ammonia can be sniffed without discomfort. And, as with all anosmics, foods are discriminated on the basis of the pure taste qualities, or by the characters of texture, astringency, and so on, which any food-complex may possess. These sensory defects are worth noting for their possible significance in connection with the theory of this special case of synæsthesia.

The following list of the 'gustatory' equivalents of spoken words was in part compiled at my request and in part written down by myself in the course of various interviews with the subject. In the latter case the words were spoken by me, and almost immediately the equivalent was given in concise, discriminating terms. Only occasionally was there some hesitation and a groping after the name of the precise food which descriptively satisfied the subjective experience. Because of the unusualness of the case, it has seemed best to transcribe in its entirety the list of 150 words that is before me in my notes.[1] The only change made is the arrangement of the words in their alphabetical order.

[1] Some further equivalents may be found in Table V.

TABLE I.

Gustatory Equivalents of Words Heard. (English.)

Ah!	Something soft.
Albert,	Not definite.
Alice,	Spanish Cream, with sprinkling of sugar.
Alfred,	Corn-bread in milk.
amethyst,	Bitterness.
Amy,	Ketchup (especially vivid).
Anne or Annie,	Apple sauce stiff with sugar.
Austrian,	White frosting on cake.
Arthur,	Small particles of delicate meat, probably lamb.
Bailey,	Marshmallows.
beast,	(see 'ease').
Belfast,	Juicy beefsteak.
Ben,	Like biting something, as if taking celluloid between the teeth.
Benjamin,	Spice cake (dark).
Bess,	Crumbs of butter. Cool.
Blanchard,	Dried catnip.
box,	Nothing definite.
boy,	Gum drops.
Browning,	Rather rich. Inclines to bitter. Might be over-done gingerbread.
Buddha,	A taste of its own, vivid but indescribable.
Cæsar,	Dry meat.
Carrie,	Onions or asparagus cooked in milk.
cause,	Hot, soft corn-bread.
Charles,	Buttered toast, not dried through.
Clara,	Lobster claws.
cox,	Sensation of irritation in throat.
crease,	Baked sweet potato with much butter.
dice,	Cool, salty.
discrete,	Warm new cake.
distinct,	Preserved pears.
Dolly,	Molasses candy, moist, fluid, taffy-like.
Dora,	Hash.
Dorothy,	'Velvet' molasses candy.
doubt,	Raw apples.
Dwight,	Beefsteak, brown, a little burnt. Or, spruce gum.
ease,	Not clear at first. Then, dry meat, when spoken quickly and sharply. If spoken more slowly, softer, pliable, creaky, like puffed rice.
Edith,	Potato soup.
Edgar,	Boiled eggs, with suggestion of the shell.
Edna,	Boiled eggs.
Edward,	Soft eggs.
Eleanor,	Chicken 'stuffing.'
Eliza,	Piece of twine in mouth.
Elizabeth,	Shreds of well-done roast beef.
Elsie,	Corn-bread in milk.
Emma,	Pie crust.
Eulalia,	Eu=olives. lalia=cooked fruit or jelly.
Eunice,	Intensely sour. Draws the jaws so that there is decided pain.
Eve,	Meat of nuts.
Ethel,	Sensation of putting thimble on tip of tongue.
Evelyn,	Fresh catnip.

fancy, Cold Boston Baked Beans.
fast, (see 'Belfast').
feast, (see 'ease').
Fillebrown, A serial experience. Water, then, quickly, gingerbread.
Florence, Maple sugar.
found, Lamb.
Francis, Baked Beans.
French, Charlotte Russe.
George, Something thick, like a charcoal tablet.
Gladys, 'Velvet' molasses candy.
grin, French toast, or fried bread.
Hall, Like rubber end of pencil pressed against tip of tongue.
Hannah, Dry, nut-like.
Harriet, Cooked cherries, inclined to bitterness.
Harris, Nothing.
Harry, Nothing definite.
Hawthorne, Agreeable, little sweet, little bitter, smooth, elusive.
Helen, Blanc mange.
Helene, Raw oat meal.
he, Dry meat.
Henry, Celery.
Hi! Something cold.
hope, Celery.
ice, Like itself.
idle, Thin, salty broth (lamb?).
Inez, Boiled cabbage (or greens) with vinegar.
intelligence, Raw sliced tomato.
interest, Stewed tomato.
Irving, Rich sort of word. Cottage pudding with thick, sweet sauce.
Italy, Very small white pickled onions.
James, Dry, brittle.
Jessie, Cool, round rolling pieces, possibly nuts.
John, Crust of soft, moist gingerbread.
Josephine, Oranges.
Joy } Rich cream candy.
Joyce }
Judith, Shreds of very salt boiled ham.
Katherine, Tea grounds, or spices.
Kitty, Soft inside part of a baked apple.
Lena, (see 'Helene').
Lida, Mutton tallow.
light, Soft juicy lobe of a grape, when spoken quickly. Chicken gravy, when spoken slowly.
Lillian (=Lilly), Sweet apple jelly.
Lola, Stewed prunes.
loud, Boiled new potato.
Louise, Bananas.
Luke, Not definite.
Lulu, Floating islands.
Mabelle, Maple sugar.
Margaret, Lima beans.
Maria, Dry browned part of custard.
Marion, Meat of walnuts.
Marjorie, Rich cream candy.
marry, Raisins.
Mary, Stewed blackberries.

Maud,	Yolk of eggs in salad.
men,	Hash.
Miriam,	Cool, pleasant.
moccasin,	Chicken.
Molly,	Sweet custard.
Nancy,	(see 'fancy').
Newcomb,	Ginger cookies.
noise,	Cold camphor-ice.
Oh!	Sweet.
Oo!	The dip of milk toast.
ox,	Nothing definite.
parlor,	Honey on bread. (Especially vivid.)
Patrick,	Nothing definite.
Phœbe,	Small pieces. Walnuts broken up.
Pierce,	Crisp, fatty part of fried bacon.
Polly,	(see 'Molly').
Rachel,	Ginger cookies.
Ralph,	Moist, cool. Raw cucumbers. (Vivid.)
rejoice, Royce,	Rich cream candy.
rice,	Like itself.
Rosalie,	Sweet, spicy, as if fumes were passing up through the nostrils.
Rosamond,	Almonds.
Ruth,	White grapes.
Sampson,	Potato salad. (Vivid.)
Sarah,	Cold metal between the lips.
Savage,	Raw apples.
Scott,	Skin of a baked apple.
Silas,	'Si' is indefinite. 'las' is candy.
Stella,	Celery.
story,	Stewed cranberries.
Susan,	Milk toast.
Tabby,	Bananas.
Tappan,	Nothing.
town,	Tongue.
tox,	(see 'cox').
tress,	(see 'Jessie').
Union.	Olives.
Uriah.	(see 'Maria').
Vivian,	Moistened bread.
who,	Thick, salty cream.
William,	Cool, clear water.
women,	Hash.
Zechariah,	'Zech' is something hard.
Zedadiah,	'diah' is something stiff, then yielding.

It should be clearly understood that the equivalents above given are meant in each instance to refer to the fact that the subject feels as if she were actually having in the mouth the described substance or some substance possessing the quality indicated.

An examination of the list will reveal the fact that all the possible qualities of gustatory, cutaneous, and tactual-motor experiences are represented. Very rarely, if ever, are the experiences confined to isolated qualities. Rather they are com-

plex, often highly so, but no more complex than the real experiences would be. A few words are gathered together here, in order to show clearly the presence of the several different qualities.

TABLE II.

Representative words yielding the various sense qualities.

Sweet: Dolly, Irving, joy, parlor.
Sour: Eunice, Inez, Italy, Josephine.
Salt: idle, Judith.
Bitter: amethyst, Browning, Harriet.
Cold: noise, Sarah, William.
Hot: cause, discrete.
Pressure: Ethel, Hall.
Pain: Eunice.
Tactual-motor: Ben, Bess, Clara, Kitty, John, Phœbe.

The color characterizations, as, for example, in the equivalents of Austrian, Benjamin, Dwight, Italy, and Ruth, are inserted solely for the purpose of more exactly describing the object referred to. They must not be taken to indicate the presence of subjective photisms accompanying the other experience.

These synæsthesias are often experienced in the ordinary course of listening to conversations, lectures, etc. Short sentences do not behave as units in producing 'tastes,' but sometimes the compound words will be effective, causing the appropriate 'tastes' to appear serially. Similarly, long words frequently behave in this fashion, parts of a word evoking quite distinct and separate 'tastes.'

The speed with which a word is pronounced is sometimes an important condition. Thus the word *light* pronounced quickly, with little accentuation on the vowel, equals "the soft, juicy lobe of a grape;" pronounced slowly, with vowel prolonged, it equals "chicken gravy." And *ease* gives "dry meat" when spoken quickly and sharply; while, if spoken more slowly, its equivalent is "something softer, pliable, creaky, like puffed rice." It follows from this that the same word has different 'tastes' when spoken by different individuals. There is no evidence, however, that in general vowels are the more influential parts of words.

The direction of the experience is always from sound to 'taste,' the reverse being possible only as the connections are remembered.

When requested to state the gustatory equivalent of a word, the subject will frequently pronounce the word to herself before making reply. Enquiry as to the purpose of this elicited the fact that such pronunciation serves often to reinforce the auditory excitation and thus make the gustatory qualities more vivid and more readily describable.

The best condition for the appearance of the synæsthesia seems to be a state of natural hunger. Thus a noon lecture arouses distracting and, since the 'tastes' are in no way satisfying, extremely tantalizing experiences, as does also table conversation before the subject herself is served with food. When faint or jaded, the synæsthesia is less pronounced. The presence of food in the mouth does not interfere with the vividness of the experience.

II.

With the exception of knowing that high piano notes gave a banana flavor, the subject was not aware that any sounds other than proper names and English words were involved in her synæsthesia until special tests were made. The following Tables present the results of these tests, in which nonsense syllables, foreign words, and non-vocal sounds were used. These Tables are self-explanatory and need no special comment.

TABLE III.

Further Gustatory Equivalents of Vocal Sounds.

Nonsense Syllables.[1]	
bik,	Something stiff and brittle.
bod,	Something sour with the texture of a pickle.
dep,	Meat, roast beef, well done.
dob,	Something soft, smooth like silk.
gur,	Sweet, like spice cake, crumby, dry.
hes,	Small particles, minced meat.
lor,	Liver.
niv,	Something with the texture of cooked pears.
sut,	Mutton fat.
tof,	Something sweet. (At back of mouth, on palate.)
vux,	Something stiff, about like Graham crackers.
yoz,	White part of egg beaten stiff. (Texture vivid.)
zaf,	Meat flavor, salty, hard, probably corned beef.
zod,	Something damp and solid.
Italian Words.	
canto,	Sweet, stiff, hard, splintery candy.
vita,	Something crunchy and sour.
nostra,	Something soft and agreeable.
cammin,	Something stiff and hard with caramel flavor.
del,	Something sweet, pleasant, cool, clear, delicate, like milk that has been poured over a baked apple.
mezzo,	Olive oil.
French Words.	
dont,	Something sweet, dry and rough.
exemple,	Something with the texture of felt.
une,	Something sour and juicy.

[1] The following yielded nothing whatever: biv, dik, hed, lat, lim, mup, sax, tem, tez, vaz, vip, wal, wat, yez, yol, yux.

mon*trer*,[1]	Custard-like, salty, an omelet.
*au*cune,	Dry fragments or crystals of something, like lumps of camphor.
German Words.	
Ge-stalten,	Gum. Something rich and sweet.
schwank*ende*,	The filling of squash pie, soft and sweet.
wieder,	Something stiff, with quality of pop-corn, mildly sour.
*ge*zeigt,	Something soft, not very pleasant.
Blick,	Something stiff, dry and tasteless, like raw macaroni.
trü-ben,	Something sweet and delicate. Something brittle between the teeth.
dem,	Cooked cocoanut.
einst,	Something a little salty.
sich,	Soft shreds of meat, moist and oily.
früh,	A clear sweet juice.
die,	Something stinging and fizzy.
zu,	Gravy.
fest,	Something sweet.
dies,	(Like English 'ease' and 'beast').
mal,	Melted butter.
wohl,	Something rich, overrich.
Ver-such,	Cooked apple, as in pie, drier than in baked apple. Gravy.

TABLE IV.

Gustatory Equivalents of Non-vocal Sounds.

Various Musical Instruments.	
A D tin whistle,	A clear sweet flavor, like Christmas candy or sugar and water. The higher the note, the less pronounced the sweet.
A C mouth organ,	Sweet and peppery at the lowest notes. The sweet increases for one-third of the upward range and then diminishes. The peppery flavor rapidly decreases and vanishes one-third of the way up.
Tuning forks,	
256 vibrations,	As if warm air were resting upon the tongue.
512-1024 "	Warm, and clear sweet; the former ceasing at the fourth note and the latter steadily diminishing.
Piano,	
A_2—E_1,	Like toast soaked in hot water.
E_1—F,	Sweet, rather strong (like licorice)—a troche.
F —g,	Mild, gravy-like.
g —c^4,	Banana (smooth, slippery).
c^4 — c^5,	Thin, insipid.
Violin,	
Lowest three notes,	Troche flavor.
From there up,	Grows sweeter, loses strength, becomes clear, delicate and sweet in flavor.

(Several other less important instruments gave results more or less similar.)

[1] The italicized portions of words contributed nothing to the 'tastes' experienced.

Noises. Several dull, flat noises evoked nothing. The rubbing of a nail on a file evoked an experience of temperature in the mouth, this being hot or cold according to the kind or degree of scraping.

III.

But what evidence have we that an actual case of synæsthesia is here being reported, and not a case of artificial association due to a lively dramatic fancy? This is a point that must be raised, for it is very easy to entertain a suspicion that these phenomena are essentially ungenuine. Now, of course, in matters of this kind general impressions and personal knowledge of the subject count heavily. And on both these grounds I have no hesitation in asserting my conviction that the above-cited equivalents are the expression of a genuine synæsthesia. But since such personal impressions are sometimes unlikely to carry conviction to others, there are, fortunately, several considerations of a less personal nature which can be brought forward. The following facts are more compatible with the theory of synæsthesia than with that of mere suggested imagery. (1) The subject herself, an accurate, careful and discriminating person, testifies that the 'gustatory' part of the experience comes quite unsolicited. It is *found*, not manufactured. This, it is affirmed, is unquestionably true now and as far as can be recalled it has always been so. In support of this account of the matter the following instance is given as illustrative. The subject, while at work in the library, finds herself tasting roast beef. Casting about for the auditory cause, she hears the murmur of men's deep voices coming from an adjacent alcove. (2) The food-equivalent of the 'gustatory' qualities experienced must often be sought for with some diligence before an adequate description of the matter can be given to the questioner. That is, the experience and the naming of it in terms of a given food are quite distinct affairs. This search was repeatedly evident in the course of obtaining the several lists, and occasionally, in fact, only the qualities themselves were given. Added to this is the fact that, as the subject reports, "some words produce a 'taste' which I seem never to have experienced before either in the pronouncing of words or in eating. Thus the equivalent of *Buddha* (the only specific instance recalled by the subject) is said to be "vivid but indescribable," suggesting olives, but not to be designated accurately by any known food. These facts are to the subject herself most strongly confirmatory of the correctness of her introspective analysis. (3) Many of the experiences are given quite definite locations in the mouth. Thus the equivalents of *Ethel* and *Hall* (tactual) are felt at the tip of the tongue; of *tox* (irritation) at the back of the

throat; of *Judith* (salt) at the sides of the tongue; of *Sarah* (cold) on the lips; of *amethyst* (bitter) "at the back of the mouth, on the roof, where the root of the tongue seems to hit it;" of *Hi* (cold) at the rear of the tongue; of *Miriam* (cool) on the anterior surface of the tongue; of *dice* (cool and salt) along the edges of the tongue; of *Florence* (sweet) over the tongue as a whole; of *Harriet* (bitter) across the rear of the tongue. As to the acid equivalent of a word, the subject says the effect is sometimes to "draw the jaws together." The sour is located along the edges and at the sides of the tongue. (4) When in doubt, the subject has a way of slightly pressing the cheeks inwards with the fingers until the satisfactory equivalent comes. This points to the sensory rather than to the imaginary character of the phenomenon. (5) The erratic nature of the matter, many words and sounds evoking no 'tastes' whatever, is precisely like that of the well known synæsthesias. (6) The subject testifies that the experience has a character intermediate between the reality of sensation and the unreality of fancy, imagined tastes seeming to be "in the head" rather than in the mouth. And (7) the equivalents possess a constancy which would hardly be possible apart from a true synæsthesia. After an interval of six months a number of words were given at random from the original list, with the result that the identical equivalents were described in almost precisely the same language.

IV.

In the hope of getting some basis for a theory of this case an examination of the data was next made with a view to ascertaining whether similarities of sound are connected with like 'gustatory' complexes. I may say at once that no great success attended this examination. (a) As a preliminary experiment I chose certain monosyllables, as given in the list below, representative of labial, dental, and other word elements, and pronounced them as distinctly as possible to the subject. The variety of 'gustatory' qualities given under each class shows that *articulatory similarity is not paralleled by 'gustatory' similarity*. This negative result is not, however, without value, since it may be taken to be confirmatory of the fact that the true excitement of the 'gustatory' qualities is auditory and not articulatory in character.

TABLE V.

Equivalents of Words Similar in Articulatory Character.

	Babe,	**Elusive, cool.**
	Pipe,	**Cool.**
(Labial)	**Maim,**	**Quite salty. Fumes pass through the nose.**

(Labial)	Valve,	Soft. Melted molasses candy.
	Fife,	Cool, slightly sour.
	Did,	Stewed tomato.
	Cease=ees=ease,	(See Table I).
(Dental)	Thin,	Not definite.
	Tent=content,	Stiff, sharp, candy.
	Church,	Meat, soft, lamb.
(Palatal)	Cake,	Like itself, but stiff cake. Cool.
	Gag,	Nothing.
(Nasal)	Sing,	Gingerbread, spicy, warm.
	Nun,	Strong. Dry baked beans, à la New York.
(Lingual)	Lul,	Trifle sour.
	Far,	Meat, beefsteak, not very juicy.

(b) The auditory similarities yielded, upon examination, a few fairly well marked correlations, but not a sufficient number to be at all satisfactory. Occasionally a prominent vowel sound seems to be effective in various settings. Thus *Oo!*, *who*, and *Susan* all suggest the eating of milk-toast; *he*, *ease*, and *Cæsar*, dry meat; *William*, and the first two syllables of *Fillebrown*, water; *Edna*, *Edgar*, and *Edward*, boiled eggs; *Bess*, *Tress*, *Jessie*, small pieces of something (*Phœbe*, however, does the same); *joy*, *Joyce*, *rejoice*, *Royce*, and *Marjorie*, rich cream candy (though *boy* 'tastes' like gum-drops). On the other hand *Dolly* does not wholly agree with *Polly* and *Molly;* and *Hi!*, *dice*, *fife*, *idle*, *Inez*, and *pipe*, though suggesting cold more than any other quality, are connected irregularly with both salt and sour. Still more distracting is it to find that identical 'tastes' are joined to very diverse sounds. Thus one 'gustatory' equivalent does duty for all members of each of the following groups: *Henry*, *Hope*, *Stella; Dora*, *men*, *women; Alfred*, *Elsie* (though *Albert* is indefinite); *Newcomb*, *Rachel; Florence*, *Mabelle; Dorothy*, *Gladys; Louise*, *Tabby*. From a careful examination of the entire list from which the above examples are taken I am convinced that it is idle to seek any rigid uniformity of connection between given auditory qualities and their 'gustatory' equivalents. And, indeed, perhaps the very complexity of both items of the experience would render this search fruitless, even if definite correlations existed.

V.

In attempting to decide whether the above-cited experiences are to be explained by the physiological or by the psychological theory, we are, apparently, in no better and in no worse case than in respect to all varieties of synæsthesia. No decisive facts are at hand. In this regard and in all essential respects, the phenomena here are typical, as any one acquainted with the literature of synæsthesia must have recognized. To conjecture that the subject's sensory defects—deafness and

anosmia—are directly or indirectly responsible for this special case, these being perhaps indications of a more or less extensive cross-circuiting of cortical currents in the regions concerned, is, after all, to indulge in mere speculation. It is, however, alluring to think that the slowness of hearing is due to the deflection of neural tensions from the appropriate auditory centres of the cortex into those regions that subserve the sense impressions of the mouth. This conjecture would be substantiated in a measure if it could be found that a decrease of auditory acuteness is accompanied by an increase in the number and vividness of the synæsthetic experiences. For upwards of a year the subject has had this particular problem before her, and although an increased vividness of the 'gustatory' phenomena does sometimes accompany the diminished acuteness of hearing, she is not willing to assert that this is not due to a more careful directing of the attention upon these phenomena. As the matter stands, therefore, this particular conjecture must be looked upon at present as lacking the desired support. Nevertheless, one who inclines, as does the present writer, to the physiological as contrasted with the psychological explanation of synæsthesias in general may find good evidence for the former, it seems to me, in the facts above cited concerning the constancy of the gustatory equivalents; the dependency of the experience upon individual fashions of pronunciation; the repeated difficulties in putting the experience, itself perfectly definite and vivid, into words which adequately describe it; and, lastly, the frequency with which the 'tastes' can be given precise localizations within the mouth. Still, here no less than in all known cases of synæsthesis, we can only regret that our theory is so lame while our facts are so secure.

THE PERIOD OF MENTAL RECONSTRUCTION.

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The following account is a statistical study of some of the experiences that are met along the highway toward intellectual maturity. The studies of Leuba[1], Starbuck[2], and Coe[3], have thrown much light on the various ways in which the religious life develops, but less has been done for the corresponding aspects of the intellectual life. Burnham,[4] has published some data on the place of doubt in intellectual and religious development, and Starbuck more or less incidentally gathered some data on what he called the period of reconstruction.[5] His returns showed that some people experience subjective transformations of varying degrees of intensity quite apart from specific religious development. Such people are at times keenly conscious of experiencing far-reaching changes or enlargements in their intellectual points of view. It is with these transformations, their causes, their presence or absence, and the comparative frequency of various types that this study is concerned.

The study is based on returns obtained by means of the following questionnaire, supplemented by correspondence and personal interviews. Three hundred twenty-seven answers to the questionnaire were received, but of these only 282 were used in preparing this paper. The purpose in rejecting the others was to avoid the fallacy of selection. The 282 came from groups in which very nearly all answered.

QUESTIONNAIRE.

Read All the Questions Before Answering Any.

Please answer by placing "yes" or "no" before the question or statement.

Mark the degree of certitude of all your answers. If you are sure of your answer, mark it A. If fairly sure, mark it B. If in much doubt, mark it C. If it is only a random guess, mark it D.

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[1] A Study in the Psychology of Religious Phenomena, *American Journal of Psychology*, Vol. VII, p. 309 f.

[2] *The Psychology of Religion*, London and New York, 1899. Also *American Journal of Psychology*, Vols. VIII and IX.

[3] *The Spiritual Life*, New York, 1900. Also *Psychological Review*, Vol. VI, p. 484 f.

[4] The Study of Adolescence, *Pedagogical Seminary*, Vol. I, p. 175 f.

[5] *Op. cit.*, chapter XXII.

The data obtained by means of this questionnaire are to be used for scientific purposes and are strictly confidential.

I. Consider the history of your mental (intellectual and moral) development. Which of the following has it been most like?

(II) 1. My mental development has been on the whole gradual, but several incidents in my life have given it noticeable impetus, without, however, introducing any great changes.

(V) 2. In my mental development I experienced one pronounced awakening or transition that gave me a point of view and unified my conception of things, but otherwise my mental development has been gradual.

(I) 3. My mental development has been gradual, so that my attention has never been attracted by subjective changes or transitions.

(IV) 4. In my mental development I have experienced one pronounced awakening or transformation that gave me a point of view and unified my conception of things. Since then, and to some extent before, I have been conscious of a number of smaller transitions which gave me new points of view and deeper insight.

(III) 5. In my mental development I have experienced a small number (say 2-10), well marked transitions. I have felt at irregular intervals that I had gained new and important points of view.

II. If, in your mental development, you have experienced a noticeable or pronounced transition:

1. What was your age when it occurred?
2. How long did it last?
3. Was it preceded or accompanied by doubt? By depression?
4. Was it preceded or accompanied by a calm state of mind? By elation?
5. In the transition, did you feel secure and that your mental foundations were becoming firmer?
6. In the transition, did you feel that old foundations were crumbling and that you were 'at sea'?
7. Was the transition followed by doubt? By depression?
8. Was the transition followed by a calm state of mind? By elation?
9. Was the transition followed by a rejection of former beliefs?
10. Was the transition followed by a readjustment of former beliefs?
11. Was the transition followed by consciously holding contradictory positions in science, religion, etc.?

III. By which of the following was this transition in your mental development most influenced? Mark with an X the one of the following that influenced you most; with a Y the next; with a Z the next:

1. The reading of any particular book or books. (If so, give name.)
2. The study of any particular subject. (If so, name it.)
3. The influence of a person. (If so, a teacher, pastor or who?)
4. Entering college.
5. Joining the church.
6. The death of a relative.
7.

IV.

1. Were you in childhood, before the age of twelve, taught religious beliefs or dogmas? If so, name church.
2. Did you receive little or no dogmatic religious instruction in childhood?
3. Have you experienced religious conversion? At what age

V. What was your occupation or schooling:

1. Between 10 and 13?
2. " 13 " ?
3. " " ?
4. " " ?
5. Between and ?
6. " " ?
7. " " ?
8. " " ?

(Fill out the blanks to suit your case, bringing it down to the present.)

VI.

1. What is your sex?
2. What is your present occupation?

Date.....Name.....

(If signing would keep you from answering frankly, do not sign.)

The returns that were used fall into two main groups, based on the immediate occupation in which those answering were engaged, and on the manner in which the returns were obtained. Those in one group were graduate students when they answered, and those in the other were teachers. I shall designate these groups respectively 'Graduate Students' (G. S.) and 'Teachers' (T).

The G. S. group comprises 170 returns in all. Eight of these were obtained through the kind co-operation of Professor W. C. Gore of the University of Chicago, 17 came from a section of the senior class in Teachers College, and the remaining 145 came from graduate students in Columbia University, mostly students in Teachers College. These were nearly all obtained during class time. With but one exception, returns were thus received from all to whom the questionnaire was submitted.

The returns from the group designated 'Teachers' came in the main from high school, normal school, and college teachers, and number 112 returns. Fourteen of these came from the Winona, Minn., High School, having been kindly obtained for me by Prin. W. A. Bartlett and Supt. C. R. Frazier. The remaining 98 I obtained from friends and acquaintances by mail. I first made a list of 50,—25 men and 25 women,—to each of whom I wrote a personal letter at the time the questionnaire was submitted. Forty-eight, or 96 per cent., sent returns. Having been so successful with this group, I repeated the effort with an additional group of 58. Of these 50, or 86 per cent., sent returns. The percentages of the different types of experiences in this group correspond so closely to those of the group of fifty, and to those of the G. S. that I feel safe in using them. Without a criterion with which to test them I should not have used them in this part of the study. Whatever the cause of the selection may have been, it evidently was not a certain type of experience called for by the questionnaire.

Although the 282 returns used in this study are practically unselected, in the technical sense of that term, the group as a whole is highly selected. It is restricted to what may be

called the upper stratum of the teaching profession. Nearly half of those answering were actually engaged in teaching, and the others had been in that work and were preparing to go back into it.

This restriction was intentional. It gives us a group that is homogeneous and so may be compared with other homogeneous groups. It would be interesting to know, for example, how the clerical, the medical, and the legal professions compare with the teaching profession in the experiences here represented.

In presenting the data I shall follow the order in which they were called for by the questionnaire. The fallacy of selection having been avoided and the numbers being fairly large, quantitive statements may be given.

The data most fundamental in the study were elicited by the first topic of the questionnaire. It called for the experience of reconstruction, with which the study is primarily concerned. The five sub-heads, or classes, under this topic form a graduated series, the order of which is indicated by the Roman numerals in parentheses. These numerals were not printed on the questionnaire as used. The classes were intentionally mixed up so as to insure a more unbiased selection. It was thought that the person answering would thus be less likely to place himself at the median and be more likely to select the type of experience that most nearly fitted his case.

The experiences coming under this head were divided into five classes, not because it was thought that this exhausted the possibilities, but because that number of differentiations could easily be made and because it seemed to cover the field with sufficient minuteness. Actually, there are probably no discrete classes at all. It is more likely that the different degrees of intensity of the experience form a continuous series, approximating the normal probability curve in its form of distribution. The data present considerable internal evidence that this is the case, the mode falling about midway between Classes II and III.

The data obtained under this topic are given in Table I. They are given separately for the sexes and for the two main groups above indicated. As only six, three men and three women, placed themselves in Class V, these are here, as throughout the study, included in Class IV, from which they do not materially differ.

The different sections of the table agree tolerably well among themselves. The variations are not greater than might be expected from the number of returns used. The four classes are all nearly the same size throughout, Class II alone showing a tendency to be larger than the others. This tendency, how-

TABLE I.

Class.	Men Number	Men Percent	Women. Number	Women. Percent	Total Number	Total Percent
			Graduate Students			
I	25	26	12	16	37	*22*
II	33	35	31	42	64	*37*
III	18	19	16	21	34	*20*
IV	19	20	16	21	35	*21*
			Teachers.			
I	15	26	13	24	28	*25*
II	15	26	15	28	30	*27*
III	17	29	12	22	29	*26*
IV	11	19	14	26	25	*22*
			G. S. and T.			
I	40	26	25	20	65	*23*
II	48	31	46	35	94	*34*
III	35	23	28	22	63	*22*
IV	30	20	30	23	60	*21*

ever, is manifest chiefly in the G. S. group, which suggests that it may be explained in part on the basis of maturity.

Age was not directly called for, but it was usually given under Topic V. When it was not so given I succeeded nearly always in ascertaining it from other sources. The average age in the G. S. group was approximately twenty-nine years, and that of the T. group was thirty-three years. This difference of four years would enable a relatively larger number from Class II of the former to pass over into Classes III and IV than would be likely to be the case in the latter. The fact that the returns from the G. S. group were marked more hastily than the others, owing to a limitation of the time to twenty-five minutes, may also have tended to swell Class II. This class appeared first on the list, which exposed it to the factor of primacy.

No marked sex difference is manifest from the table. If any exists, it again occurs in Class II which is quite uniformly larger for the women than for the men. If an explanation for this is necessary, it cannot be sought in maturity, for the women average about the same age as the men. It would be explained on the assumption that women are more conservative than men, so that they do not give themselves up so readily to rapid and far-reaching mental transformations. As some of

the data to be taken up later indicate such a difference, this point will be referred to again.

Psychologically, of course, these four types of mental development are equally significant. They are, perhaps, all equally normal and one leads to culture and insight as well as another, a statement well borne out by the data. There are returns from people of distinction in science and philosophy in all four classes.

Although these four classes are all equally significant as types of mental development, they are not equally spectacular. Classes III and IV are more picturesque than I and II. Descriptions of subjective experiences were not called for, aside from those briefly given in the questionnaire, nevertheless, a number of those who sent returns by mail gave such descriptions, and a few others I obtained from members of Class IV on request. It would consume too much space to publish them all, or even many of them, but two of Class IV are inserted. It must not be inferred, however, that all the experiences even in this class are as definite and clear-cut as those cited.

Up to the age of nineteen or twenty I had retained a certain orthodox view of the world, though never a church member. But my interest in scientific reading upset me. I went through somewhat the disintegrating crisis described in *Robert Elsmere*, and the reading of the book brought me to the constructive outcome where the higher relations of religion and science seemed clear.

Although I had been given little religious instruction in youth, I absorbed an 'orthodox' view of the world which I had no occasion to question. At the age of twenty-two the doctrine of evolution, the writings of Horatio W. Dresser, and the stimulating influence of a teacher gave me new insight. I obtained a conception of the world as an evolving, progressing unity, and I felt that I now understood. The 'orthodox' views caused some friction, but on the whole the accompanying emotional tone was one of elation. To make the major readjustments took me about one year.

The following citation from John Stuart Mill's *Autobiography*, page 66, is an excellent illustration of the extreme type of the reconstructive experience.

When I had laid down the last volume of the traité[1] I had become a different being. The 'principle of utility' understood as Bentham understood it, and applied in the manner in which he applied it through these three volumes, fell exactly into its place as the keystone which held together the detached and fragmentary component parts of my knowledge and beliefs. It gave unity to my conception of things. I now had opinions; a creed, a doctrine, a philosophy; in one among the best senses of the word, a religion.

The experiences in Class III resemble those in Class IV. They are usually less acute, although not always, and include

[1] Dumont's *Traité de Legislation*, three volumes.

a smaller section of the mental life, thus giving opportunity for several to occur. One person distinctly described seven and another five, but generally the number is smaller. To make this phase of the matter concrete, a number of first-hand descriptions should be cited from each class, but space does not permit this.

The experiences of Classes II and I are progressively less pronounced than those of the other two classes. People who placed themselves in Class II were conscious of times when their mental growth was accelerated, when they came upon new unifying principles, but the matter made little impression on them. The people in Class I realize that their points of view have changed in the course of time, but they can point to no specific influences or occasions that have brought about the change. For example, one person responding by mail said:

"My growth has been gradual,—no sudden transitions or changes. . . . . I need to think a matter over long before I adopt a new notion. By that time I often forget when I got it."

Topics II and III of the question list were meant to apply mainly to Class IV. Class I was by the nature of the case excluded, but nearly all the members of Class III supplied data, and many of Class II did.

The data elicited by the first two questions in the second topic can be satisfactorily considered only in relation to Class IV, although members of Classes II and III also attempted to answer them. These questions request (1) the age at which the transition occurred and (2) the length of time it lasted. All the members of Class IV, thirty men and thirty women, answered the first question, and twenty-one men and twenty-four women gave specific times under the second.

The ages at which the transition occurred vary for the men from 14-42 years, with an average of 22.2 years and a median of 21 years. Forty-seven per cent. of the ages fall between 18 and 22 inclusive, 63 per cent. between 18 and 25 inclusive, and 16⅔ per cent. fall below 18 years. For the women the ages vary from 13 to 32 years, with an average of 20.25 years and a median of 19.5 years. Fifty-three per cent. of the ages lie between 18 and 20 inclusive, 70 per cent. between 18 and 22, and only 10 per cent. fall below 18 years. The men show a greater range of variation than the women and average nearly two years older. This difference agrees well with the difference in the time of the advent of puberty in the two sexes, which indicates that the period of reconstruction is likewise a function of maturity, in part at least.

The average ages found by Starbuck are higher than those given here.[1] He found them to be 24 years for the women and

[1] *Op cit.*, p. 279.

24.5 years for the men. How to account for this difference is not clear. The fact that the ages in Starbuck's returns were given incidentally may account for it in part, a person having met the experience late being more likely to mention it; and it may in part also be owing to the fact that he studied miscellaneous groups. A person taking a college course and following an intellectual calling may meet this period earlier than one who does not.

The length of time occupied by the transition is not so easily given as the age at which it occurred. Few, if any, had any hesitation in saying when reconstruction began, but many found it difficult to say when it ended. The times given by the men vary from a month, or less, to three years, and those given by the women vary from three months to four years. Seventeen per cent. of the men and ten per cent. of the women indicated that the experience is continuous. One-third of these admitted that they were in the midst of the process. The remaining two-thirds may either be similarly explained, or they merely continue to feel the elation coming from a unified mental life.

The average time spent in the transition by the men was 1.6 years and by the women 2.1. The women evidently take a longer time to adjust themselves to the new point of view than the men. This is in harmony with the common observation that women are, as a rule, more conservative than men. In the reconstruction, usually long cherished, but now inconsistent views, must be modified or discarded, and although the women are intellectually convinced of the new truths, their feelings linger.

The ages at which the transition occurred as given by Class III are not so reliable as those given by Class IV, where all answered the question, but they may be mentioned in passing. Fifty-one ages were given by the men and 25 by the women, coming in each case from about half that number of persons. The ages vary from 8-40 for the men, with an average of 20, and from 10-32 for the women, with an average of 20.1.

The data gathered by questions 3-11 under Topic II are condensed in Table II. The percentages of the positive answers only are given. Many negative answers were also recorded, but the tendency is for people to leave a blank where a positive answer cannot be given.

It is clear that all the features having to do with 'storm and stress' increase as we pass from Class I to Class IV. In fact, the column for Class I is practically blank.

A marked falling off in doubt and depression is noticed after the crisis has been passed, and there is a corresponding increase

TABLE II.

Class	Men					Women					M. & W.
	I	II	III	IV	Total	I	II	III	IV	Total	
During transition.											
Doubt.....		15	63	77	34		13	36	70	29	32
Depression ...		6	43	53	22		6	29	60	22	22
Calm.....		21	34	47	23		8	29	33	17	20
Elation		10	23	23	13		2	11	33	11	12
Secure		35	63	70	38		17	53	50	30	35
'At sea'.....		10	51	60	27		6	32	63	24	26
After transition.											
Doubt.....		8	37	20	15		6	18	37	15	15
Depression ...			14	17	7			14	27	9	8
Calm		29	54	63	34		13	45	47	26	30
Elation		13	37	43	21		4	29	43	18	20
During and after transition.											
Rejection.....		21	43	50	26		6	21	43	17	22
Readjustment		35	78	80	44	4	19	53	70	36	40
Contradictory		8	20	23	12		2	11	47	14	13

in calm and elation.[1] Those who were afflicted with doubt and depression during the transition frequently gave a positive answer also under 'calm,' and sometimes even under 'elation,' but they usually indicated that there was an alternation of moods. A similar alternation was also frequently indicated between feeling secure and feeling 'at sea.'

'Storm and stress' is not a necessary accompaniment even in Class IV. Eighteen per cent. of this class report that they experienced no doubt, depression, or feeling of 'at sea'; this in spite of the fact that 64 per cent. of this 18 per cent. had received religious instruction and that 73 per cent. had readjusted their religious beliefs. These percentages are almost identical with those of Class IV as a whole, which are 65 per cent. for religious instruction and 75 per cent. for readjustment of beliefs. This is strange when it is noted that it is usually the incompatibility between early religious teachings and later scientific and philosophic instruction that causes the friction. What it seems to indicate is that storm and stress is, in the main, a function of temperament. No matter what mental readjustments have to be made, some people do this with little or no emotional disturbance.

The intensity of the storm and stress period in those that do

[1] A number of those that answered the questionnaire suggested that the word 'satisfaction' be substituted for 'elation.' Had this been done, the caption would no doubt have drawn a still larger percentage of positive answers.

experience it varies greatly. Although not called for, three mentioned that it was very painful, and two of these had contemplated suicide. Taking the rubric 'doubt' as a criterion of storm and stress, 32 per cent. of the people studied passed through such a period. This figure may be slightly too low as 13 in Classes III and IV, making 5 per cent. of the total number, left Topic II unanswered, but the percentage would certainly not rise above 38 or 40. This is not necessarily at variance with the assertion of Starbuck (*o. c.* p. 214.) that over 60 per cent. of average American young people pass through such a period. His figures include the storm and stress frequently experienced at the onset of adolescence, while ours include only the period of reconstruction.

Questions 9, 10, and 11 are not specifically 'storm and stress' questions and so require separate mention. Seventeen per cent. in Class IV indicated that they rejected former beliefs entirely. Seven per cent. did so in Class III, and 2 per cent. in Class II. The others who answered that question in the affirmative also answered the next question, usually indicating that there was partial rejection and partial readjustment. The large number indicating a readjustment of former beliefs shows this to be a constant accompaniment of mental reconstruction. The fact that it is so would lead one to think that certain types of religious and other dogmatic instruction are responsible for at least some of the storm and stress that exists.

It is not explicitly revealed by this study to what extent storm and stress is a phenomenon of individual, and to what extent of social psychology; to what extent it is a result of the process of growth and development, and to what extent it is a result of instruction and environment during childhood.

No matter how narrow and dogmatic the instruction has been, a certain type of temperament seems to be necessary to bring about emotional disturbances later. This is evidenced by the fact mentioned above, that some people who have had much dogmatic instruction readjust their beliefs without storm and stress, and by the figures of Table IV below. The percentages of those having received much religious instruction are nearly the same in all four classes.

No striking sex differences are revealed in Table II. In the last three items, however, the figures are quite uniformly divergent for the sexes, which would indicate the existence of such differences. Twenty-six per cent. of the men rejected in whole or in part their former beliefs, as against 17 per cent. of the women; and 44 per cent. of the men readjusted their beliefs, as against 36 per cent. of the women. This rejection and readjustment of long cherished beliefs are radical acts, and the fact that the women do this less than the men is again in har-

mony with the assumption that they are more conservative. Still, this difference in the figures might be explained otherwise, an explanation, however, that does not seem to me to have much weight. It is indicated in Table IV that the women of this group have received slightly less religious instruction than the men, and in Table III that they are less attracted by science and philosophy and therefore study them less. But it is these subjects that are most likely to unsettle certain forms of beliefs.

The average percentages for holding contradictory beliefs are 12 for the men and 13 for the women. But in Class IV, where the issue is clearest, the percentages are respectively 23 and 47, indicating that in this class the practice is fully twice as frequent among the women as among the men. This would indicate again the more conservative nature of women. They find it hard to discard former beliefs of whose inconsistency they have nevertheless become intellectually convinced.

In drawing this inference, I have not forgotten that just the opposite conclusion could be drawn from the figures under Classes II and III. I noticed frequently in gathering the data that the women were much more cautious, and apparently secretive, in marking this item than the men. They appeared unwilling to confess that they had held contradictory beliefs. Some answered the question in the affirmative and then erased the answer. This indicates that all the figures from the women should be higher in order to make them comparable with those from the men.

The causes influential in bringing about the transition were elicited by the rubrics under Topic III, and are condensed in Table III. The percentages are based upon the entire number of entries that were made. In all there were 490 of these, 253 by the men and 237 by the women. Counting only those who made entries, this gives an average of 2.4 per man and 2.5 per woman.

TABLE III.

	Men	Women
Personalities	35 per cent.	45.4 per cent.
Science and Philosophy	33 "	18 "
Psychology	4 "	3.4 "
Literature	5.6 "	8.3 "
Entering College	8.6 "	16.3 "
Joining Church	6 "	2.6 "
Miscellaneous	7.8 "	6 "

In classifying these entries I made originally ten classes, respectively for (1) Personalities, (2) Philosophy, (3) Science, (4) Social Science, (5) Bible and Science of Religion, (6) Psychology, (7) Literature, (8) Entering College, (9) Joining Church, and (10) Miscellaneous. Under the last head I placed unnamed items as "a book" or "a subject of study," and such subjects as "travel" that were mentioned but seldom and would not logically fall in the classes made. Deaths, which composed 3 per cent. of the influences for the men and 6 per cent. for the women, were classified under personalities, regarding them as the subtraction of personalities from the environment. The figures for philosophy and the different sciences, with the possible exception of psychology, all showed the same trend and so they were combined.

The sense in which these things may be regarded as causes of the transition cannot be expressed in a sentence. They differ in this respect both for the items themselves and for the people mentioning them. A personality, as a teacher, may do one thing for one person and quite a different thing for another person, and its influence may never be like that of metaphysics, for example. A teacher in the classroom might supply the principle for reconstruction, or he might merely suggest a fruitful line of reading. In conversation, in letters, and on the blanks, the statement was frequently made that the items mentioned should not be regarded as sufficient causes, but rather as inciting causes. They precipitated a reconstruction for which the mind had long been getting ready through study and experience. The particular influence serves usually to supply, or lead one to find, a unifying principle for things that are already in the mind, but which have heretofore been more or less unrelated. The development is at bottom an educational one that has become ripe for integration. In itself probably no influence has power to reconstruct. To be efficacious, the mind must be ready for it, and what would influence one might not influence another.

The difference between the people that are conscious of transitions and those that are not is probably in the main temperamental. This means that they instinctively react differently to similar situations. Some of the persons in Classes I and II are so conservative, or cautious, or reactionary regarding new ideas that they do not adopt them outright, but 'get used' to them so gradually that they are never really conscious of how they got them. Others again may be quite the opposite in attitude and continually reconstruct their mental content as they pass along the highway of learning and experience, so that large transitions are precluded. Other attitudes, or native and acquired mental equipments, might be posited to explain all the various types of experience in this respect.

A perusal of Table III reveals a number of sex differences that are worth noting. As would be expected, personalities count more with women than with men. They form nearly one-half the influences mentioned by the women and only about one-third of those mentioned by the men. Teachers appear to exert about equal influence over the sexes. They comprised 18 per cent. of the items for the men and 21 per cent. for the women. This leaves a balance of 17 per cent. and 24 per cent. for personalities closer than teachers, such as parents, brothers, sisters and friends, or a ratio of 3-2 in favor of the women. Science and philosophy, on the other hand, count more with men than with women, in the ratio of nearly 2-1. The fact that men study these subjects more than women, and therefore are influenced more by them does not explain away this difference in the figures, but points in the same direction. The reason why men study them more is not so much conventional as it is because they are more attracted to them. Literature is not given as a cause as much more frequently by the women than by the men as might have been expected. But when it is known that Emerson and Browning are the authors most frequently mentioned, this may be accounted for. The writings of these authors might almost as well have been classed with philosophy, for they supply the same kind of unifying principles. Entering college, by which those answering meant either the event of going off to college or the influence of the college course, appears decidedly more momentous for women than for men. This is very likely owing to the fact that it forms more of a contrast in their lives than it does in those of the men. Joining church, on the other hand, impresses the men more than the women. The explanation is probably similar to that of the preceding, but is reversed for the sexes. Boys are more likely than girls to get away from the influence of the church, and so coming back and joining it forms more of a step for them.

The fact that the relative amount of influence exerted by the various items was called for has not been taken into consideration in the preceding discussion. It was faithfully given but each item was assigned with about equal frequency to first, second and third places, so that weighting seemed unnecessary.

Topic IV, pertaining to religious instruction and to conversion, was included especially for the purpose of separating the religious experiences from those that are more purely intellectual. That the period of mental reconstruction is a phenomenon independent of religious conversion is indicated by the data gathered by question 3 under this topic. Unfortunately the second part of this question, calling for the age of conversion, was not on the paper at first. I added it after more than half

the data had been collected. Nevertheless I got the ages of conversion from 32 men and from 20 women. These range for the men from 11 to 24 years with an average of 16 and a median of 15, and for the women from 10 to 25, with an average of 14.8 and a median of 14. For the men there seem to be two modes, one at 13-14 and one at 18, and for the women there is one at 14. All these figures show that conversion is an earlier phenomenon than mental integration, on the average nearly six years earlier. The same fact also came to light in Starbuck's returns. In Class IV, I obtained the age of conversion from 12, or from 20 per cent. In only two of these instances did the ages for the two experiences coincide.

TABLE IV.

	Religious Instruction			Conversion		
Class	Men	Women	Total	Men	Women	Total
I	60	48	55	35	16	28
II	69	59	64	50	22	36
III	71	75	73	46	54	51
IV	70	60	65	50	37	43
Aver.	69	61	64	45	31	39

The rest of the data gathered by this topic are summarized in Table IV. It has already been pointed out that the amount of religious instruction received in childhood does not correlate in any significant way with the experiences of mental reconstruction. Some correlation exists, however, between mental reconstruction and the experience of conversion. This is in harmony with the assumption that the persons falling toward Class I in the curve of distribution adjust themselves more gradually and with less subjective upheaval in all things. They are more calm and deliberate in temperament than those at the other end of the curve, who are more emotional.

In all, 69 per cent. of the men and 61 per cent. of the women said that they had received much religious instruction in childhood, and 45 per cent. of the men and 31 per cent. of the women had experienced religious conversion. Why the men should experience conversion more frequently than the women seems to require explanation, for women being more emotional, and presumably more religious than men, the opposite would naturally be expected. In part, the explanation very probably again strikes back to the fact that boys get away from church and home influence more than girls. After having sowed some 'wild oats' they come back to their former sphere of life, pass-

ing through the process of conversion in doing so. Girls pass out of the influence of the home and the church less frequently than boys and so have less occasion to become converted. The greater conservatism of women may also enter into the explanation. They are less given to abrupt changes than men.[1]

In all 110 answered as having experienced conversion. Seventy-eight per cent. of these had received much religious instruction and 22 per cent. little or none. Although the opposite might again be expected, the explanation is probably not far to seek. To have received religious instruction means to have been brought up in a religious home. The members of such a home are most likely to come under the influence of church services, revival meetings, and other factors that stimulate conversion. No doubt heredity is also a factor. The predisposition in church-going families for deep religious experiences may be inherited like other traits. Furthermore, religious instruction in childhood is taken much as a matter of course, having little meaning attached to it, hence when conditions become ripe to give it content, the experience is likely to overwhelm the mind. All former instruction appears in a new light and gets a significance essentially new. But this cannot well be the case with those that have received little or no such instruction. They have nothing at hand to be made meaningful and so are more free to go about the matter intellectually and become adjusted gradually to the deeper meanings that the experiences of life unfold.

Topic V calls for biographical items pertaining to occupation and schooling. It was thought that irregular schooling, or getting one's education late in life, might be a cause contributing to transitions consciously experienced. A few instances point to the conclusion that this may be a subsidiary factor, but it certainly does not enter into many cases.

It will be of interest to give a brief account of the returns that were not included in the foregoing data. These are condensed in Table V.

Fifty blanks, together with a return stamped envelope and a request for a reply, were sent to Methodist ministers, and the same number to members of the Chicago Board of Trade. The names in each case were taken in alphabetical order from published lists. Eight in each group returned the blanks unanswered, while twelve clergymen and three business men kindly supplied data. The remaining thirty clergymen and thirty-nine business men were not heard from.

[1] It is not meant, of course, that all women are more conservative than men, but that they are more so on the average. It might well be that the most conservative person in the world is a man, and the most radical person a woman.

TABLE V.

Class	I	II	III	IV	Blank
Clergymen	1		3	8	8
Business Men	1	2			8
Teachers	4	2	1	1	1
Miscellaneous	4	9	1	8	
Total	10	13	15	17	17

The fact that all but one of the clergymen that answered had passed through periods of reconstruction is no doubt significant, and it is to be regretted that all did not supply data. It may be equally significant that none of the business men answering had experienced reconstruction, but three replies is manifestly too small a number to bear much weight.

Fifty blanks were also sent to Wisconsin high school teachers, but with an unstamped return envelope. Nine replies were received, as given in the table. I wish now that I had stamped the envelopes so as to make the data more nearly comparable with those from the clergymen and from the business men. The fact that my supply of blanks gave out (600) made it impracticable to extend the distribution.

The miscellaneous group comes from two city superintendents and from a friend at Columbia University. To the superintendents, who had expressed a willingness to assist me by submitting the blanks to their high school teachers and their grade principles, I sent 25 to one and 75 to the other, and received in return 5 and 12 respectively. The remaining five returns, collected by the friend above mentioned, came from people that were neither teachers nor graduate students. Of five requests for assistance sent to university people, only one brought a favorable response.

The data of Table V were obtained under such a variety of conditions and the numbers in each group are so small that little can be inferred regarding selective influences. They do indicate, however, that reliable questionnaire data can be obtained only under exceptional conditions, such as were mine at Columbia University. In addition to returns from friends and acquaintances, one must be able to get people in groups, such as are afforded by school or college classes. But even then it takes no less pains to gather reliable data by means of the questionnaire method than by any other legitimate method. That reliable data may be gathered in certain departments of psychology by means of the questionnaire method, supple-

mented by correspondence and personal interviews, is borne out by the results obtained by Galton and others. The method does not apply everywhere in psychology, but neither does any other method apply everywhere. Taking it for granted that the subject of this study was worth investigating, by what other method could this have been done?

The reliability of measurements based on such methods as 'right and wrong cases' and 'average error' may be calculated mathematically, but this is not so readily done with questionnaire data. One may obtain the respondent's own degree of confidence in his answers, but just what this is worth is not known; and one may get him to repeat his answers after he has forgotten how he answered on the former occasion, and then compare the consistency of the results. In fact, one aspect of the reliability of a person's answer might, and should, be extensively investigated by the second method suggested.

TABLE VI.

Certitude Blank			A		B		C		D	
Topic	No.	%	No.	%	No.	%	No.	%	No.	%
I	61	21·5	158	56	59	21	4	1·5		
II	619	45	551	40	175	12·5	29	2	7	·5
III	302	68	94	21	36	8	14	3	1	
IV	435	69	177	28	14	3	1		1	

On the accompanying questionnaire the request was made of the person answering to indicate his degree of certitude. He was requested to mark his answers A, B, C, or D, according as he was sure, fairly sure, in much doubt, or making a random guess. The data, in probably a too much condensed form, are given in Table VI. As far as certitude was indicated, it is of an unexpectedly high degree. Comparatively few answers were marked C or D. Under Topic I all the C's and 63% of the B's were given by members of Classes I and II, those that had experienced no pronounced transitions. The degrees of certitude of the separate questions under the other topics were also not distributed in equal proportions.

On the average approximately half the answers were left blank as to certitude. About ten per cent. of these I investigated by means of personal interviews and found that nearly all felt certain and wished their answers to be marked A. Only two asked to have theirs marked B. I received the impression that when people are certain they feel that they need not indicate that fact.

Before the questionnaire was printed in the form in which it was used, a trial copy was prepared and mimeographed. This

varied but little from the form that was used, and was answered by twenty-seven persons that later also answered the printed copy. The influence of memory from the first to the second report was slight because an interval of two months elapsed between the two, and none of the people expected to have the blank submitted to them again.

Comparing the answers in Topic I, 16 of the 27 were alike in the two returns, 6 had checked adjacent classes, *i. e.*, they had, for example, moved from Class I to Class II, or *vice versa*, and 5 had checked in such a way that the two returns seemed clearly discrepant. But when the answers to Topics II, III and IV were compared the discrepancies between the two returns were quite inconsiderable. Practically the same experiences of doubt, depression, elation, religious experience, etc. were indicated, and the causal influences mentioned were also nearly the same, differing only in minor details. This suggested to me that the answers to the detailed experiences called for under Topics II, III and IV were more reliable than the classification of those experiences called for by Topic I. This proved valuable, for it justified me in a few instances in placing the respondent in a different class from the one he had himself indicated. In a few returns the answers under the later topics clearly showed that the wrong class was checked under the first topic. Wherever possible, however, I consulted the person that supplied the data before making a change. These consultations confirmed the suggestion that the answers to the later topics were more reliable than those to the first.

Under the space for the respondent's signature were placed these words: "If signing would keep you from answering frankly, do not sign." Eight and one-half per cent. of the men and 14 per cent. of the women did not sign. Most of these, however, were members of a large class in which the instructor called especial attention to the fact that the signature would not be necessary. There was very little spontaneous tendency to withhold the signature.

PSYCHOLOGICAL LITERATURE.

The Vocation of Man, by JOHANN GOTTLIEB FICHTE. Translated by William Smith, with biographical introduction by E. Ritchie. Chicago, Open Court Publishing Company, 1906. pp. lxii + 178.

Spinoza and Religion, by ELMER ELLSWORTH POWELL. Chicago, Open Court Publishing Company, 1906. pp. xiii + 344.

An Introduction to Philosophy, by GEORGE STUART FULLERTON. New York, Macmillan Company, 1906. pp. xiii + 322.

Concepts of Philosophy, by ALEXANDER THOMAS ORMOND. New York, Macmillan Company, 1906. pp. xxvii + 732.

An Outline of the Idealistic Construction of Experience, by J. B. BAILLIE. London, Macmillan and Co., 1906. pp. xx + 344.

Everyday Ethics, by ELLA LYMAN CABOT. New York, Henry Holt and Co., 1906. pp. xiii + 439.

Few works by any philosophical writer are more stimulating than Fichte's "Vocation of Man," which keeps ever before the reader the intimate connection of abstract speculation with the profoundest problems of human life; no work of its author exhibits so clearly the spirit and substance of his system. The Open Court Publishing Company renders the student a distinct service in adding this standard translation of it to its series of cheap reprints of philosophical classics.

In "Spinoza and Religion," Professor Powell, of Miami University, examines a question of perennial interest to students, and one still perhaps unsettled. Was Spinoza, as his contemporaries generally judged him, the 'prince of atheists,' or was he, as he has frequently since been regarded, a 'God-intoxicated' mystic? Taking the view that religion essentially involves belief in a higher power, or powers, of a personal kind, and that Spinoza's 'God' is plainly impersonal, the author concludes that Spinoza's system really is, and was intended to be, atheistic and anti-religious. The question turns chiefly on the interpretation of such technical terms as *intellectus infinitus*, *cogitatio infinita*, and *idea Dei*, and on the interpretation of certain apparently contradictory passages, such as Eth. II, 3, where it is said that "in God there is necessarily an idea as well of his essence as of all things that necessarily result from his essence," and Eth. I, 17, Schol., where an intellect and will like ours are expressly denied to God. Professor Powell shows considerable skill in dealing with the difficulties raised by the ambiguities in Spinoza's language, his great principle in explaining away the apparent implications of consciousness in God in such passages as the first here referred to being that of accommodation to scholastic modes of expression. He carries this principle so far, however, as to make it difficult to exonerate Spinoza from the charge of deliberate deception. If Spinoza was no mystic, his system is certainly a stupendous mystification. But if, as the author has so well shown, Spinoza's thought is full of contradictions, why not include his theism and mysticism with the rest?

Opinions naturally differ as to the best method of introducing col-

lege students to the study of philosophy. In a discipline which depends so much for its success on the personality of the teacher as well as on the character of the student and the conditions of the curriculum, there is probably no 'best' method. In the view of the present writer, there is no better approach to the problems of reflective thinking than through a sympathetic study of the history of Greek philosophy. It is impossible, however, to read Professor Fullerton's excellent "Introduction to Philosophy" without recognizing the many advantages of his method of approach, especially when used as a supplement to the historical. The arrangement of topics—the general nature of philosophy, the problems of the external world, the problems of the mind, the various types of philosophical theory, etc. —is admirable, and the distribution of the material well balanced. Particularly to be remarked is the skillful way in which Professor Fullerton, starting with the assumptions of the plain man, leads the student into the intricacies of the problems as they appear on mature reflection. His own views are expounded and defended with energy and exemplary clearness, and many of these the teacher of the book is likely as vigorously to combat; but the significant thing is that these views are presented with a singular freedom from dogmatism and that the student is everywhere stimulated and encouraged to think for himself. The book is the ripe product of many years of successful teaching, and for purposes of instruction is easily among the very best of its class.

From an introduction for beginners we pass in Ormond's "Concepts of Philosophy" to an elaborate treatise capable of taxing the patience and thought of the most advanced philosophical student. The work shows the same high qualities of grasp and penetration, of originality and conservatism, as the author's earlier volume, "The Foundations of Knowledge;" here, as there, the thought is always independent, thorough and painstaking, moving leisurely and untrammelled in wide open spaces. Ormond's point of departure is the opposition of science with its mechanical, and metaphysics with its teleological categories. Beginning with an analysis of the most general conceptions underlying respectively the scientific and philosophical constructions of experience, he then proceeds synthetically, by a successive advance from the physical to the social and thence to religion, to lay the foundations for a final, unified interpretation. He seeks to show that the concepts and methods of physical science, while applicable throughout the whole range of experience, are inadequate to the demands of synthesis which arise, with increasing urgency, as we ascend the scale of the sciences, and that they point to their transcendence in metaphysics, which subordinates the mechanical to the teleological, and in religion, in which the unity required is complete. By this method a system is constructed which carries to its conclusion the 'Copernican revolution' initiated by Kant, the central contention being that the fundamental reality is 'consciousness,' the energy which is aware both of itself and of its object; ultimately, the appeal is to an 'eternal consciousness.' But the unification of truth demanded by philosophy requires, it is held, not only the synthesis of science and metaphysics, but also the synthesis of knowledge and belief, and this final synthesis is an act of will. Hence God, freedom and immortality, to which theoretical considerations 'point,' appear, in the end, as practical postulates.

The idealistic construction of experience is carried out in a still more rigorous fashion by Professor J. B. Baillie, of the University of Aberdeen. His method is the method of Hegel, and his argument a free reproduction of the argument of the 'Phenomenology of Spirit.'

He seeks to show (1) that each phase of experience embodies in a specific way the one spiritual principle that animates all; (2) that each is distinct from the other simply by the way it embodies this principle; (3) that each is related to the others and to the whole in virtue of its realizing the principle with a certain degree of completeness; (4) that the whole of experience is a necessary evolution of the one principle through various forms logically connected as a series manifesting the principle. The main stages of the development are, first, that in which the individual subject is conscious of objects as *prima facie* outside the subject; second, that in which it is conscious of self as other than, and yet implicitly one with the subject; and third, that in which all sense of otherness is overcome and self and subject are transparently one (p. 134). No instructed reader can well deny the force and fascination of the method. It 'adopts,' if one chooses to say so, the principle it seeks to demonstrate, but it does this in no arbitrary way, for the principle is not external, one to which experience has to be fitted, but immanent; experience, in other words, essentially involves some sort of unity and relation of subject and object. The difficulty lies in connecting its various phases without mutilating any one of them, and in showing that the postulated unity is a really constitutive, and not merely an ideal or regulative principle of the whole. Professor Baillie has done, perhaps, all that can reasonably be expected to make the principle clear. The pragmatist who regards the unity of experience as confined to the individual experience from moment to moment will not be convinced, but he can hardly afford to ignore Professor Baillie's sympathetic, but penetrating, criticism (pp. 10-25).

Mrs. Cabot's instructive and well-written work on "Everyday Ethics" may be heartily commended to teachers in secondary schools who are looking for an experienced guide in the development of moral consciousness in their pupils. The book is the outcome of years of experience with the minds and needs of just such pupils. It avoids technical and abstract discussions and deals, in a live way, with the problems in which pupils of the high school age are, or can readily be made, interested. Its central ethical doctrine is that duty is found in fidelity and efficiency in one's chosen vocation, that "out of loyalty to our chosen work springs all moral life." Added to the main body of the text is a key to teachers, containing many excellent suggestions, numerous questions and additional illustrations.

Smith College. H. N. GARDINER.

The Elements of Psychology, by EDWARD L. THORNDIKE. A. G. Seiler, New York, 1905. pp. xix, 351.

An Introduction to the Theory of Mental and Social Measurements, by EDWARD L. THORNDIKE. The Science Press, New York, 1904. pp. xii, 212.

The aim of *The Elements of Psychology* is "to help students to learn the general principles of psychology." The volume is "designed to serve as a text-book for students who have had no previous training in psychology, who will not in nine cases out of ten take any considerable amount of advanced work in psychology, and who need psychological knowledge and insight to fit them to study, not the special theories of philosophy, but the general facts of human nature." The book is divided into three parts (Descriptive Psychology, Physiological Basis of Mental Life, and Dynamic Psychology), an Introduction and a Conclusion.

The Descriptive Psychology (Part I) is a modified abstract of James's *The Principles of Psychology*. It gives a general account of

'mental states,' 'thoughts,' and 'feelings,' with a final chapter on the 'functions of mental states.'

Part II is, with the exception of chapter xi, neurological. It gives, in terms of the neurone theory, the principal structural and functional characteristics of the central nervous system and of the sense organs. This section of the book is abundantly (even superfluously) illustrated from standard neurological texts.

Dynamic Psychology (Part III) is defined as the "science of the mind in action." It has to do with "the facts and laws which determine what any human being will think and feel and do, how he will learn, why he will misunderstand, when he will be interested, what habits he will form, to what sort of intellect and character he will attain." This 'science,' as it appears in the book under consideration, shows the impress of modern biology, both of the descriptive and of the statistical type. Its emphasis falls upon 'instincts' and 'capacities,' 'native and acquired tendencies,' 'inborn connections,' and 'situations.'

It is clear that dynamic psychology is one form of the psychology of reactionism. Its interest in consciousness may almost be said to be incidental. Dynamic psychology is the psychology of 'behavior,' of 'conduct,' of 'human life.' It is concerned with consciousness only in so far as consciousness is linked to stimulus and to organic movement; only in so far as it is a factor in adaptation. It studies the 'function' of thoughts and feelings, and "the function of thoughts and feelings . . . . is to influence actions" (*i. e.*, movements). Emphasis is accordingly laid upon three sets of connections: connections between stimulus and consciousness, connections between one thought or feeling and another, and connections between consciousness and organic movement: in the author's terms, connections of impression, association and expression. Each of these may be further divided into original (unlearned) and acquired (learned) connections or tendencies to connection (six sets in all).

Now, by a liberal interpretation of the venerable principle of associative relationships, dynamic psychology proceeds to state, in the form of 'laws,' the conditions under which the six kinds of connection are realized; *i. e.*, the way in which (1) stimulus leads (under native and acquired tendencies) to consciousness, (2) consciousness to consciousness, and (3) consciousness to movement.

Since it is in these 'laws' that Professor Thorndike's dynamic psychology comes to its chief issue, it is perhaps worth while to inquire whether the formulations in question really preserve (in spite of the generous use of capital letters) the dignity and the significance of the scientific law. They are in reality rules;—not laws, either in the sense that they state invariable connections of antecedent and consequent or as predictive anticipations of fact. As descriptive expressions of the dependence of a phenomenon upon an indefinite number of heterogeneous factors whose values are uncalculated and whose modes of combination are unknown, these 'laws' (especially the "entire Law of Association") are the counterpart of the glittering generality of common sense. Formulations of this kind are impressive, and their indeterminate nature saves them from refutation; but their usefulness to science is uncertain and their effect upon "the naïve student" unfortunate.

Even if the formulas in question were proper psychological laws, the still more fundamental objection might be raised that they are, from the point of view of mind, external and superficial. They refer either to the organic conditions and consequences of consciousness or to the 'secondary' factors in the successive or linked association. This crude use of association in psychology is surely obsolescent and

should be obsolete. The more refined analytic methods long ago discarded it. The biological rehabilitation of the text obscures but does not conceal the stock principle of associationism.

I have dwelt upon the author's associative connections both because they furnish the basis and superstructure of the Dynamic Psychology and because they illustrate at once the weakness and the strength of the point of view. The author's method is the method of gross anatomy; the method that regards consciousness as a whole, that calls it a stream, notes its rate and volume, its fascinating evolutions and metamorphoses, its multifold relations to objects, to the processes of knowledge, to conduct, to the physical organism; and that contents itself, on the side of analysis, by distant reference to 'feelings' and 'thoughts.' Whenever it comes to cross-section, to careful scrutiny of the snap-shot picture of mind, to the histological analysis of the individual thought or feeling, there—unless its champion happens to have a gift for introspective subtleties—the method balks. Consider the work under review. Problems of the first sort are treated with competence; problems calling for histological treatment are either avoided or drawn in caricature. Take the subject 'sensation.' The sensation of the laboratory is scarcely mentioned, and the author, realizing that "definitions must be rough" (and apparently they *may* be, since the reader is the "naïve student"), actually confuses the sensation-element with Fechner's sensation-magnitude and with Münsterberg's sensation-atom! Similarly, stimulus is defined in two inconsistent ways (17 and 28); and fusion and colligation are gravely said (in a 14-line account of "the constitution of percepts") to be combinations of "brain processes." Again, it is, in the reviewer's opinion, doubtful whether a student who had been 'introduced' to psychology through the *Elements* could, on occasion, give an intelligible definition of the terms 'mental state,' 'thought' and 'feeling;'—could tell whether the terms were synonymous, whether a mental state is a group of feelings or thoughts, or whether a thought is a particular kind of feeling or mental state. Action, finally, offers a glaring instance of the lack of analytic insight into the constitution of mind. The dynamics of action is chiefly interested in the way in which feelings lead up to, and issue in, movement. The very term 'action' has entirely lost its psychological meaning and implies simply muscular contraction and its bodily results. The whole problem of action, considered as a matter of consciousness, is missed, or, at most, it emerges in such bootless form as the contention that movement images are rare antecedents of voluntary action.

When an author has succeeded in writing a text-book that is at once interesting and impressive, a book of high pedagogical merit and of clever arrangement of fact and principle, of instance and illustration, detailed criticism, especially of the negative sort, is apt to appear captious if not carping. Apart, however, from the demands of the science, the critic finds, in a case like the present, ample justification for his strictures—if nowhere else—in "the right of the student . . . to demand a fair representation of the science as a whole" (preface, page x).

In his book on the Theory of Mental and Social Measurements, Professor Thorndike "has had in mind the needs of students of economics, sociology and education, possibly even more than those of students of psychology, pure and simple." The book presents in an interesting and simple, if not systematic, way the principles and methods employed in the modern science of biometry. The present writer has found the volume serviceable for occasional reference and for the collateral use of students, both in psychophysics and in the statistical

study of psychological problems. It contains, in an appendix, convenient tables for arithmetical computations.

Cornell University. I. MADISON BENTLEY.

Skalpieren und ähnliche Kriegsgebräuche in Amerika, von GEORG FRIEDERICI. Vierweg, with map. Braunschweig, 1906. pp. 170.

In this monograph of characteristic German exhaustiveness, the author discusses the etymology of the word, scalping, and gives its history from Herodotus to the present time. Although it did occur in antiquity, it seems to have completely vanished in Europe, while head trophies or sometimes other parts of the body that were cut off, took its place as evidences of victory in war. Scalping is essentially a characteristic trophy of the New World, and in an interesting colored map the author shows how it probably originated among the Indians of the eastern part of America although it had probably an independent origin in a much smaller area in Central South Africa. In America, it spread westward from the region of the Great Lakes, north to Hudson Bay and west to the Rocky Mountains and south to Mexico and later nearly to the Pacific Coast. Over nearly all of Africa, in Central Mexico and the Pacific Coast, it occurred occasionally, although in this latter region heads were often used as trophies.

Folkways, a study of the sociological importance of usages, manners, customs, mores and morals, by WILLIAM GRAHAM SUMNER. Ginn & Company, Boston, 1907. pp. 692.

This book, in both its plan and presentation, reflects the vigorous and unique personality and the power of original thought of its author. He first characterizes *mores*, then the struggle for existence, labor, wealth, societal selection, slavery, abortion, infanticide, killing of the old, cannibalism, then passes to sexual *mores*, and marriage institutions, social codes, incest, kinship, blood revenge, primitive justice, peace unions, uncleanness and the evil eye, points out how *mores* can make anything right and prevent condemnation for anything. In illustration of this, he characterizes sacral harlotry and child sacrifices, then passes to consider popular sports, exhibitions, drama, asceticism, education, history, life, policy and virtue versus success. He uses the Latin word *mores* to designate popular usages and traditions when they include a judgment that they are conducive to societal welfare and exert a coercion upon the individual to conform to them, although they are not co-ordinated by any authority. He has also sought to bring the words *ethos* and *ethology* again into familiar usage. After analyzing folk ways, he attempts to justify this process by a series of illustrations, and opines that this in order to be successful must go into details. These of course are immense, so that he can only select those deemed most fit from a larger array of facts which were used in forming his generalizations. Indeed, the original plan of the book has been curtailed, for he intended to include demonism, primitive religion and witchcraft, the status of women, evolution and the *mores*, usury, gambling, societal organizations and classes, mortuary usages, oaths, taboos, ethics, æsthetics and democracy. The first four of these we are glad to know are already written. The index is deserving of special commendation.

The Káfirs of the Hindu-Kush, by SIR GEORGE SCOTT ROBERTSON. Illustrated by A. D. McCormick. Lawrence & Bullen, London, 1900. pp. 658.

This new edition has been re-edited and reconstructed as indeed historic needs made necessary, if it was to be brought to date. Since the first edition appeared in 1897, the whole of Kafiristan has been con-

solidated. Moslem missionaries have been massacred, and sometimes barbarous executions are thought to be more deterrent to violent and predatory crimes than the endless hangings and life imprisonment which characterize the British government of India. Moslem missionaries do not worry nor exasperate, but take plastic boys to Kabul and make them zealous followers of the great prophet of Arabia. The fervor of proselytes is proverbially without limit. Whatever the future of this land, it will not change its religion, for here the Kafirs have become Sheikhs. In emergencies the old heathen rites will crop up again, but the country is now Mohammedan.

Weird Tales from Northern Seas from the Danish of Jonas Lie, by R. NISBET BAIN. With twelve illustrations by Laurence Honsman. Kegan Paul, Trench, Trübner & Co., Ltd., London, 1893. pp. 201.

This book consists of eleven tales translated from the Danish of Jonas Lie whose work has long been well known to all interested in such themes. He is best where he tells the weird legends of his native province, Nordland, in which he was himself brought up. The folklore of these lonely, subarctic tracts is in keeping with the savagery of nature. Elves and gnomes are rarely friendly, but all the supernatural beings that haunt sea and shore in these regions are malignant, malific, hating man and delighting to mock his toil and sport with his despair.

Hinter Kerkermauern; Autobiographien und Selbstbekentnisse, Aufsätze und Gedichte von Verbrechern; ein Beitrag zur Kriminalpsychologie, von JOHANNES JAEGER, Meckleuburg, Berlin, 1906. pp. 436.

We have here an interesting and unique volume made up almost entirely of writings of prisoners. They are classified first, as autobiographic or confessional; second, those describing the cause of the crime, or the criminal propensity; third, those expressing the meditations and reflections of criminals in prison; fourth, religious thoughts; fifth, the opinions of criminals on social questions; sixth, their views on penology. Many poems are included. The author is a prison chaplain who appears very little, but expresses his most emphatic dissent from the conclusions of the Lombroso school. He even denies that there are any typical varieties of criminals or that there are morphological or psychological traits, but thinks that crime is essentially a product of the *milieu*. Criminals, he insists, show the same psychological traits that others would show under like conditions. This opinion he bases upon fifteen years experience with them. These psychological documents certainly give a most interesting inner view of the souls of a class of people, knowledge of whom is commonly a book of seven seals.

Woman, by BERNARD S. TALMEY. The Stanley Press, Chicago, 1906. pp. 228.

This book is written by a gynecologist and is designed for physicians and students of medicine. In the introduction, we have thirteen brief chapters of phallicism, prudery, results of silence, love and passion, etc. Then follows the evolution of sex, a chapter each upon anatomy and the physiology of the sexual instinct and act. Part fifth is devoted to pathology and then follow three larger parts on hygiene, psychology, and morality respectively. The book is written with extraordinary plainness and with little attempt to beat the bush in discussing delicate matters.

Man and Woman, the female the higher type, by WILLIAM T. BELFIELD. E. W. Broman, Chicago, 1907. pp. 111.

Mr. Belfield is well known as a writer upon the pedigree and heredity of the horse and to this he has contributed many important and valuable points. In this pamphlet he turns his attention to stirpiculture in the human field and discusses briefly and aphoristically such topics as puberty, senility, descent, the comparison of the sexes, nameless diseases, etc., with particular reference to their evolutionary bearings.

The Inter-generation Period, by CHARLES H. CHANDLER. From the Wisconsin Academy of Sciences, Arts and Letters. Vol. XII, pp. 499-504. Issued in October, 1899, in advance of the general publication.

The author examined nearly 16,000 dates of births of New England families and finds that on the average, the period intervening between successive generations is 33⅓ years. He concludes, after a summary, that the more nearly complete the record of births in each generation and the greater the number of generations included in the examination, apparently the greater is the tendency to a mean period of one-third of a century. The very ingenious graphic method represented in the diagrams is of itself interesting. The factors which lengthen the inter-generation are large families and marriages in which the woman is much younger than the man.

A Study of Longevity, by CHARLES K. CHANDLER. Reprinted from the Transactions of the Wisconsin Academy of Sciences, Arts and Letters. Vol. XIV, Part I. Issued September, 1903, in advance of general publication. pp. 56-62.

The writer has based his work upon the records of eight families extending back to the beginning of the seventeenth century and containing more than 100,000 names. From this it appears that there has been little if any gain in respect to the proportion of deaths among young children. This the writer ascribes to the increase of the perils of infant life, due to growing urban population which balances all hygienic advance. The median age seems, however, to be advancing, which indicates a decrease of deaths in youth and early manhood. This permits the pessimistic view that our advance in overcoming disease is not wholly a blessing because many who by the beneficent working of the law of survival of the fittest would have been removed early in life are now preserved to become the progenitors of feeble offspring. There is a marked decrease in the proportion of people attaining extreme age, despite the increase of the average length of life.

The Roots of Reality, being suggestions for a philosophical reconstruction, by ERNEST BELFORT BAX. E. Grant Richards, London, 1907. pp. 331.

Starting from certain postulates united on the consistency of consciousness, the author attempts to rough hew certain indications of the direction in which future philosophic constructions must take place if they are to be even relatively adequate to the needs of the up-to-date philosophic mind. The author is frankly and fully an idealist, although not perhaps in the form in which idealism has loomed largest for modern thought, but he seeks a more adequate formulation. The chief topics are the general problem of conscious idealism, the illogical and the logical as the ultimate elements, the individual consciousness, reality, true and higher consciousness, the final goal of all things and the problems of metaphysics. The author is loyal to, and has a subdominant interest throughout in, sociological problems.

Philosophie der Unbelebten Materie; hypothetische Darstellung der Einheit des Stoffes und seines Bewegungsgesetzes, von ADOLF STÖHR. Mit 35 Figuren. Barth, Leipzig, 1907. pp. 418.

In 1904, the author published a volume entitled Zur Philosophie des Uratomes, in which he developed the view that physical processes could be sketched between the two extremes of mono- and poly-energetics. Since then, much rather revolutionary experimental work has been done and a very stimulating theoretical construction published by Sahulka, which attempts to explain gravity, molecular energy, heat, light and electricity in a purely mechanical and atomistic way. Stöhr differs from Sahulka in assuming that the impenetrability of atoms is a problem, not a certainty, and secondly, he has a very different formula for the relation of two atoms in action upon each other. In general, inanimate matter is an aggregate, built up of elements of from one to seven orders, with various vibrations, times, rotations, etc. As a whole his conclusion hardly may be said to take too little cognizance of the recent excellent work done on ions.

The Persistent Problems of Philosophy. An introduction to metaphysics through the study of modern systems, by MARY WHITON CALKINS. Macmillan & Company, New York, 1907. pp. 575.

This book, the author frankly tells us, was not written to lure unphilosophical students into the field, although designed for beginners, but is an attempt to combine the essential features of a systematic introduction to metaphysics with those of a history of modern philosophy. The chapters are as follows: The nature, types and value of philosophy; Systems of numerical pluralism; Pluralistic materialism, the system of Hobbes; Pluralistic spiritualism, the system of Leibnitz; Pluralistic spiritualization, the system of Berkeley; Pluralistic phenomenalistic idealism, the system of Hume; An attack upon dualism and phenomenalism, the critical philosophy of Kant; Monistic pluralism, the system of Spinoza; The advance toward monistic spiritualism, the systems of Fichte, Schelling, and Schopenhauer; Monistic spiritualism, the system of Hegel; Contemporary philosophic systems, the issue between pluralistic and monistic personalism. Appendix consisting of biographies and bibliography of the modern rise of philosophy, together with summaries and discussions of certain texts.

Pragmatism, a new name for some old ways of thinking. Popular lectures on philosophy, by WILLIAM JAMES. Longmans, Green & Company, New York, 1907. pp. 309.

We have at last in this volume Professor James's exposition of pragmatism. He discusses what it means, the present dilemma in philosophy, some metaphysical problems pragmatically considered, the one and the many, pragmatism and common sense, pragmatism's conception of truth and relations to humanism and to religion. The form of the book is eminently popular and this affords the author an opportunity to bring to bear his remarkable and charming style which is always engaging and captivating. A fuller review will follow.

The Philosophy of Goethe's Faust, by THOMAS DAVIDSON. Edited by Charles M. Bakewell. Ginn & Company, Boston, 1906. pp. 158.

Though dead, he yet speaketh. These six lectures were given in the winter of 1896 and in them Mr. Davidson told what Faust, whom he knew almost by heart, had come to mean for him. He believed that true poetry might include all the content of philosophy and much of that of religion presented always in concrete form. To him the content of Faust meant the entire spiritual movement toward individual emancipation composed of the Teutonic Reformation and the Italian Renaissance in all their history, scope and consequences.

In the Fire of the Heart, by RALPH WALDO TRINE. McClure, Phillips & Co. New York, 1906. pp. 336.

This book seems to be written in the author's best style and tells us how time deals with nations, describes governments, great place movements, public utilities, labor, the agencies for attaining the greatest good, and finally the best chapter of all, the life of the higher ideals and power.

Das Wesen des Menschlichen Seelen- und Geisteslebens, als Grundriss einer Philosophie des Denkens, von BERTHOLD KERN. Hirschwald, Berlin, 1907. pp. 434.

This physician develops a somewhat unique system of philosophy in eight chapters which discuss the following topics. The problem of the soul and the methods of studying it; the foundation and the essence of knowledge; the life of the will; the identity of the soul and body; logical thought and knowledge; noetic thought, life and development; the unity of the psycho-spiritual processes of sensation, feeling, will and thought; spiritual freedom and ethics.

Der Mechanismus des Denkens, von HENDRICK DE VRIES. Mit 5 Textabbildungen. Hager, 1907. pp. 64.

After twenty years of careful study and reflection, the writer reached the conclusion that the essence of thought can be understood, and the old idea that we never can know what it is, is all wrong. Beginning with memory, the writer gives us a diagram of how he conceives it to have been represented in the mechanism of the optic lobes. He then describes the nature of the simple and the complex idea and then comes to the will, the processes of which he represents in a very complex and yet intelligible series of diagrams. Consciousness is evolved from speech and his theory on this topic is expanded into great complexity, taking its point of departure from the current schematisms concerning aphasia. In the supplement, he discusses the centre of the first and second optic word image. Whatever else may be said of his conclusions, a few of them are certainly most stimulating, original and ingenious. Of course, in presenting such views, the writer goes far beyond the standpoint to which he is logically compelled by facts.

Social and Ethical Interpretations in Mental Development, a study of social psychology. By JAMES MARK BALDWIN. 4th ed. The Macmillan Co., New York, 1906. pp. 606.

This fourth edition is not materially altered, the changes being chiefly additions of literary references and notes. The third edition brought the work into practically its final shape. The author's genetic logic is closely related to this book in that it seeks to trace the meaning of consciousness. The result is summed up in the phrase "the individual is a social outcome in a social unit and knowledge is common property and not a private possession." This thesis to the author's mind destroys the epistemological atomism and subjectivism of individualistic theories of knowledge making personal logical thought an outcome and not a unit, just as the first of these truths destroys individualistic theories of state and society.

Growth and Education, by JOHN MASON TYLER. Houghton, Mifflin & Company, Boston, 1907. pp. 294.

The author has collected here much matter concerning the growth of different organs and systems which are scattered through medical journals or are published in separate monographs. He assumes growth to be more important than learning. Balance of organs is

important, and right physical, mental and moral habits. The author is a great believer in the educational value of the old New England farm. A general idea of the scope of this book may be presented by the topics of the chapters which are as follows: Present needs in Education, Man in the Light of Evolution, Hints from Embryology, Growth in Weight and Height in the Neuro-muscular System and the Visceral Organs, Mortality and Morbidity, Constitution and Periods of Life, The First Three Years, The Kindergarten Period, In the Grammar Grades, In the High School, Physical Training, Play and Gymnastics, Manual Training. As a whole, the book is a rare and very valuable combination of the results of science and of robust common sense. It is a book which ought to be accessible to every teacher of all grades. The title of it gives only a faint indication of its range and scope.

Vybrané stati pedopsychologické a pedagogické. G. S. HALL. Se svolením auktorvym prelozil Mauer. úvodem provází. Prof. Dr. Frant. Cáda. Praze, 1906. pp. 199.

Selected paido-psychological papers, translated into Czech with permission of the author (Dr. G. Stanley Hall). Introduction by Dr. Frantisek Cada. Prague, 1906. Contents:

Introduction, Dr. G. Stanley Hall and His Activities. 1. Notes on the Study of Infants. (From *Ped. Sem.*, June, 1901, Vol. 1, pp. 127-138.) 2. Some Aspects of the Early Sense of Self. (From *Am. Jour. of Psy.*, April, 1898, Vol. 9, pp. 351-359.) 3. Contents of Children's Minds on Entering School. (From *Ped. Sem.*, June, 1891, Vol. 1, pp. 139-173.) 4. Moral and Religious Training of Children. (From Princeton Rev., Jan., 1882, Vol. 10, pp. 26-48.) 5. The Love and Study of Nature a Part of Education. (From Rep. of State Board of Ag. of Mass., 1898, pp. 134-154.) 6. Children's Lies. (From *Ped. Sem.*, June, 1891, Vol. 1, pp, 211-218.) 7. The Ideal School as Based on Child Study. (From Forum, Sept., 1901, Vol. 32, pp. 24-29.)

This volume consists of a translation and epitome of seven of the psycho-pedagogic papers of G. Stanley Hall which have been translated into Bohemian by Professor Dr. F. Cáda. The whole is prefaced by a sketch of the life of Dr. Hall. This much we gather from a kind note of Dr. Cáda, but we are unable to say more of the book.

Symmetrie und Gleichgewicht. Ausstellung in Königl. Württ. Landesgewerbemuseum, Stuttgart, 1906. Katalog, im Auftrage der Königl. Zentralstelle für Gewerbe und Handel, von GUSTAV E. PAZAUREK. Stuttgart, 1906. pp. 160+16.

This unique little book first discusses the etymology and the idea of symmetry and equilibrium in art. The author then shows their precursive forms in nature and then passes to some details of symmetry in dress, arms, heraldry, art, handiwork, and shows the different treatment of symmetry in the conservative and oppositional styles. A number of illustrations show the extremes both of symmetry and of glaring departures from it. The book as a whole is designed as a supplemental guide-book through the royal exposition of the museum in Stuttgart.

Handbuch der Kunstgeschichte von ANTON SPRINGER. V. Das 19. Jahrhundert, Dritte Auflage, bearbeitet und ergänzt von Max Osborn. E. A. Seeman, Leipzig, 1900. pp. 452.

This new volume of the third edition with its 490 cuts and twenty-three colored plates constitutes one of the best of the series which as a whole is distinctly the best we have in its field. To set forth the history of art in recent years is a tremendous task, especially if one re-

quire himself to select representative pictures of all schools and lands which shall illustrate the chief and typical tendencies. While we cannot speak with the authority of expertness upon this matter, the fame which this series has already attained and the high quality make it probable that it will not soon be superseded.

Psychology, general introduction, by CHARLES HUBBARD JUDD. Vol. I of a series of text-books designed to introduce the student to the methods and practice of scientific psychology. Charles Scribner's Sons, New York, 1907. pp. 389.

The author has adopted what he calls the genetic method, which, as he uses it, is very different from the evolutionary method. Functional seems to us a better term. The physiological conditions of mental life have been given a conspicuous place and much attention is given to ideation. The writer first treats the evolution of the nervous system, then that of man and then passes to a general analysis of consciousness, treating each of the five senses and their relations to space, time and unity. He then discusses stress and expression, instinct and habit, memory and ideas, language, imagination and the formation of concepts, concept of self, impulse and voluntary choice, forms of dissociation and practical applications. The book has 56 illustrations, the most of which, however, are not new. To our thinking, it is in general too abstract for a beginner's book. While there are many, even a great many illustrations, the author's *tendence* is too much in evidence. Nevertheless it should be welcomed, and certainly presents many things not found in other texts.

L'Année Psychologique, publiée par ALFRED BINET. Masson et Cie, Paris, 1907. pp. 495.

This volume of l'Année contains an unusual number of original memoirs. Some of the most important of these are on the relativity of space, the progress of psychophysics, perception of psychic facts, the relations between insects and the colors of flowers, work of Pawlor on the secretion of the so-called psychic saliva, relation between medicine and pedagogy, and between psychology and metaphysics, between touch and muscular sense, visual memory of normal and abnormal children, muscular and articular sensibility, acquisition of habits by animals, the writing experts in the Dreyfus trial, Weismann's theory of the genesis of instinct, scientific study and experimental work, mental enfeeblement in dementia praecox, senile dementia and general paralysis, chronic mental confusion, the question of race in psychology, the psycho-chemic conditions of the functioning of nervous centres, the co-operation of the school and the family, the development of the problem of aphasia, pain and pain nerves, sensitive tracts in the nervous system, sexual dimorphism in plants, the modern doctrines of morals and the psychology of thought.

The Psychological Clinic, edited by Lightner Witmer. The Psychological Clinic Press, Philadelphia, March 15, 1907. pp. 40. Vol. I, No 1.

This is a new journal for the study and treatment of mental retardation and deviation, publishing nine numbers a year; each of 28 or more pages at a subscription of $1.00 per annum. It is published primarily in the interests of retarded and defective children and will take cognizance of all forms of such work for mentally and physically abnormal children and youth and juvenile delinquents and dependents, including the blind and deaf. It will appeal to those having philanthropic interests. Professor Witmer has for ten years conducted a psychological clinic. The purpose of the movement which

his work represents is fourfold; the investigation of the phenomena of mental development of school children, especially those who are retarded, and (2) a clinic supplemented by a training school at the hospital, (3) the offering of practical work to those interested alike in teaching, medicine, social observation and training, and (4) the training of students for a new profession, namely that of the psychological expert who shall make his career in connection with the school system. The first number makes an attractive appearance, an interesting case of infantile stammering in a boy of twelve is well studied, a principal of a Philadelphia school describes a case of juvenile delinquency, the editor has a long article on university courses in psychology in general, but with special reference to this kind of work, while there is another department of book reviews, criticisms, notes, news and comments.

The Philippine Journal of Science, edited by PAUL C. FREER. Published by The Bureau of Science of the Government of the Philippine Islands. Manila, October, 1906. Vol. I, No. 8. pp. 791-08.

The Philippine Journal of Science, edited by Paul C. Freer, is an important part, one might almost say, of the Philippine question in this country. Some of its work is excellently done. It is generally rather more practical than scientific in its range and scope. It is plain, however, that the purpose of the editors is not limited to the utilitarian side, but the anthropology, folklore, flora, fauna, geology, rainfall, etc., of the islands are included.

On the Functions of the Cerebrum; the frontal lobes, by SHEPHERD IVORY FRANZ. Archives of Psychology. Edited by R. S. Woodworth. No. 2. March, 1907. New York, The Science Press. pp. 64.

The author first gives some account of the frontal lobes as centres of motion, inhibition, attention and intellectual states, then describes his own method and his results, which show loss of habit after extirpation of the frontals, the effect of surgical shock upon the attention, associations, the retention of habit after extirpation of parts of the cerebrum, the formation of association after removal of both frontal lobes, emotion, will, condition of animals from which the lobes have been removed and the nutrition.

THE PROCEEDINGS OF THE PHILADELPHIA MEETING OF EXPERIMENTAL PSYCHOLOGISTS.

The fourth annual gathering of experimental psychologists was held at the University of Pennsylvania on April 17th and 18th, 1907. The papers were of a high degree of excellence, and the discussions which followed were interesting and illuminating. A novel feature of the programme was a round table discussion of the plans and methods of instruction in psychology. The visiting psychologists were invited to attend the meetings of the American Philosophical Society which were held in Philadelphia during the same week. Professor Witmer entertained the psychologists most hospitably at the University Club, and conducted them on tours of inspection through his unusually well-appointed laboratory.

In the session devoted to Comparative and Child Psychology the following papers were presented:

Statistics of Retardation in a City School System, by J. E. BRYAN.

A statistical study of data obtained from several thousand children

of all school-ages and school-grades. There comes to light a thoroughgoing parallelism between physical anomaly and mental retardation. (This paper has since appeared in full in the *Psychological Clinic.*)

Clinical Examination of Retarded Children, by J. D. HEILMAN.

A description of the mode of procedure followed in the examination of retarded children, and a presentation of certain results obtained, with illustrations from individual cases. The procedure consisted essentially in obtaining from the school records a list of pedagogically retarded children, and the preparation of a blank record-sheet for the systematic enumeration of data. In addition to the mental, physical and motor stigmata, these sheets recorded such data as home and family conditions, and school standing. The individual cases presented showed that the capacity of pedagogically retarded children may vary between the limits of good mentality and hopeless idiocy.

(1.) *Individual Variation in Acquisition and in Retention*, by E. J. MYER, and (2) *The Associative Processes of the Dog, the Cat and the Squirrel*, by S. S. COLVIN. (Presented by J. W. Baird.)

(1) Mr. Myer's investigation dealt with the differentiation of the memorial types in school children, and the relative memorial efficiency of the various types. His preliminary work had to do chiefly with a series of tests which should identify the type present in a given individual. This was followed by a series of experiments which aimed to determine the stability and the relative efficiency of the different types. In this preliminary report the tests employed were described and demonstrated. (2) Professor Colvin's research aimed to obtain quantitative determinations of the ability of certain animals to distinguish colors, and to establish associations between groups of memorial material. A series of boxes of uniform size and shape, but of different colors, was prepared and furnished with food. Only one of the boxes,—the standard,—could be opened by the animals. After a preliminary series of experiments during which the animals learned to select and open the standard box, this box was exposed in various combinations with the others, and the reactions of the animals,—dogs, cats and a squirrel,—were noted. It was found that all of the animals were able to distinguish between the six more prominent colors of the spectrum, and even between but slightly different tones of the same color. No color showed any pronounced superiority over any other. The results also show that the animals tested possess a rapid acquisition, and a fairly tenacious memory. (These two papers will appear in full in a forthcoming volume of the *Psychological Review* Monograph Series.)

In the session for Laboratory Methods of Research and Instruction the following papers were read:

The Control of the Hipp Chronoscope in Psychometry, by J. B. KRAUSE.

Experiments in the standardization of control-instruments showed that a fall-screen can be standardized so that it will mark off a time interval correct to $.22\sigma$, with a mean variation of less than $.3\sigma$. Tests with a pendulum showed that the constant and the variable error are approximately one-half as large as those of the fall-screen. Data were presented showing the degree of uniformity of reading which can be attained when the instrument is properly adjusted. In a series of 4,000 records taken in groups of 160,—comparison made between chronoscope and fall-screen at the end of each group,—the average difference between readings at the beginning and the end of groups was found to be $\pm 1.008\sigma$. In a smaller group of similar records with pendulum control the average difference was but $\pm.36\sigma$.

A Finger Plethysmograph, by HENRY H. GODDARD.

This new form of the instrument was designed to avoid two defects in plethysmographs now in use,—loss of time in adjusting to the body, and impossibility of reproducing exactly a former adjustment. The problem is solved by attaching the instrument to the thumb-nail by a clip, and then adjusting the pneumatic system to the ball of the thumb by means of an easily legible micrometer screw.

Note on a New Method of Preparing Color Stimuli of a Definite Saturation, and its Application to the Study of Weber's Law, by J. H. LEUBA.

Dr. Horn and Miss Blake, of Bryn Mawr College, have published the results of a series of colorimetric determinations wherein was employed a new and ingenious method of preparing chromatic stimuli. The stimuli were composed of light transmitted through filters filled with colored solutions of different composition, and at different degrees of concentration. The method is commendable in that it permits of an accurate reproduction and a minute gradation of stimuli. Professor Leuba demonstrated the method in detail, and pointed out that it furnishes the means for a new confirmation of Weber's Law. The application of the method gives results which show that, within limits, the amount of color solution which must be added to produce a just observable difference in color, is a constant fraction of the amount of color-substance already present.

Student Apparatus for Courses in Experimental Psychology, by E. B. TWITMYER.

A demonstration of the methods employed at the University of Pennsylvania. Each laboratory group is supplied with a set of apparatus which becomes the personal property of the students. Many of the instruments are designed by Dr. Twitmyer, and constructed by the laboratory mechanician; they are simple in design and remarkably efficient in operation. The plan and scope of the course was described in detail.

A Demonstration of a Cheap but Efficient Air-Plethysmograph Constructed from a Lamp Chimney, by E. C. SANFORD.

The glass fits over the hand; it is closed at one end (the wrist) by a thick bandage of putty, and at the other end by a cork fitted with glass tubes for pneumatic transmission, and for the equalization of air-pressure.

In the session given to Research Problems the papers read were as follows:

Memory for Absolute Pitch, by J. W. BAIRD.

Tests made upon a remarkable case of pitch memory were described. The eighty-eight notes of the piano, presented in difficult order, were identified with an average error of about four per cent. The distribution of errors showed the middle and upper regions of the key-board to be most readily identified,—a result which was confirmed by chronoscope records of reaction-times. The reproduction of tones by means of the voice, and the Stern *Tonvariator* showed a surprising degree of accuracy. Tests were made with tones of various clang-tints; pipe organ (flute, diapason, reed and other stops), *Tonvariator*, tuning-forks (mounted and unmounted), Galton whistle, bells, glasses, rods, etc. The discussion emphasized the importance of eliminating the participation of relative pitch memory (or 'sense of interval') in the investigation of absolute pitch memory. (This paper will appear in full in the *Monograph Supplements*.)

The Fluctuation of Minimal Visual Stimuli, by C. E. FERREE. (To be published in full in the *American Journal of Psychology*.)

Experimental Studies of Reasoning Processes, by E. C. SANFORD.

A demonstration of a convenient method for the experimental investigation of the reasoning processes. Puzzles of various sorts, and problems involving the simple arithmetical operations furnish especially appropriate material. An exercise in long division, for example, is worked out in full by the experimenter, who then erases certain figures from divisor, dividend, quotient, intermediate products and remainders, and substitutes crosses for the missing figures. The subject is asked to determine what figure is represented by each cross. Such exercises facilitate at once the inspection of the subject's reactions, and his introspection of his mental processes. The results show that habit plays a prominent rôle in the method of attacking a problem, and also marked individual variations of method (confirming the earlier work of Lindley). All reasoning processes show a tendency to conform to a type of association under limiting conditions of apperception. The logical type of the syllogism is a formula which applies to many sorts of things—as to reflex actions (Pierce)—and not at all a true description of the psychical experience of inference.

Fluctuation of Attention to Cutaneous Stimuli, by L. R. GEISSLER. (Published in full in this number of the *American Journal of Psychology*.)

The Method of Just Perceptible Differences, by F. M. URBAN.

If a subject is required to make a series of comparisons between two stimuli, S_1 and S_2, his judgments vary without any apparent order or regularity, so that one is unable to predict what the judgment will be in a given experiment; but in a great number of experiments each judgment tends to occur in a certain percentage of all the cases. This indicates the formal character of random events, and we introduce the notion of a probability of a judgment of a certain type. This means that there exists a definite probability that the comparison of the stimuli, S_1 and S_2, will result in the judgment 'greater,' 'less' or 'equal.' These probabilities depend upon the amount of difference between the comparison-stimuli, and they may vary if the conditions under which the judgment is given are changed. An analysis of the experimental procedure which is called the method of just perceptible differences shows that for the just perceptible positive difference there exists the probability ½ that the judgment 'greater' will be given, and that there exists the probability ½ that on the just imperceptible positive difference the judgment 'greater' will not be given. Theoretically these differences are equal, and the cause of the differences which are always found in actual determinations is shown. Similar considerations hold for the just perceptible and the just imperceptible negative difference. The just perceptible negative difference is that amount of difference for which there exists the probability ½ that the judgment 'less' will be given, and the just imperceptible negative difference is that difference for which there exists the probability ½ that a 'less' judgment will not be given. The general notion of a just perceptible difference may, therefore, be defined as that amount of difference for which there exists the probability ½ that it will be recognized. Now the considerations which lead to these conclusions have certain practical consequences. The first and most important is, that one is not tied down to any specific order of presenting the pairs of comparison stimuli, if one records all the judgments. The second consequence is that one must not always use the same pairs of comparison-stimuli,

but that one must 'vary the steps by which one approaches the threshold.' One finds, too, that the accuracy of the method of just perceptible differences compares favorably with that of the method of right and wrong cases, and that it does not require the hypothesis of any specific law of distribution. From this it follows that the method of just perceptible differences is not only highly serviceable for all purposes which do not require a high degree of accuracy, in which cases there is little objection to using it in the form which is now in use, but also that it is capable of a high degree of accuracy. The theoretical considerations are illustrated by the results of experiments with lifted weights. The results of the computation are compared with the actual observations, and it is found that they coincide in a remarkably high degree, even when the number of observations is rather small.

The Relation of the Four Taste Qualities to One Another, by J. W. BAIRD.

The experimental method consisted in establishing the liminal concentrations of sugar, hydrochloric acid, sulphate of quinine and sodium chloride, which could, under normal conditions, be identified as sweet, sour, bitter and salt. Then after exhaustion of the taste organs by strong solutions of each, the subject was asked to identify subliminal solutions and distilled water. A procedure without knowledge was employed, and 5 ccm. of each solution was given,—the subject being required to wash the liquid about in the mouth cavity during the process of identification. Several interesting results were obtained. Water after sweet tasted sour, after sour and after bitter sweet, and after sweet bitter. Subliminal bitter was identified after fatigue with sweet, with salt and occasionally with sour. Subliminal sweet and salt were identified after exhaustion with bitter. These results indicate that bitter is not unrelated with the other taste qualities as Kiesow affirms.

The Influence of Practice upon the Shortening of Reaction-Times (Sound Reactions), by CHARLES VUILLEUMIER.

Sixteen hundred reactions obtained from each of four subjects were treated by several statistical methods; the group averages and the mean variations all show the acquisition of celerity and uniformity of reaction with the progress of practice. The following table gives the averages of groups of 200 experiments for all four subjects, the results being averaged in groups of 200:

I.	II.	III.	IV.
117.06σ	154.97σ	163.15σ	134.11σ
108.62	135.77	139.07	128.23
102.6	111.83	129.95	123.75
98.4	108.83	130.24	124.23
96.4	99.77	128.51	111.44
91.1	95.98	108.54	106.81
92.2	96.73	113.7	103.78
94.07	102.1	111.43	108.65
Grand average, 100.04	113.24	128.07	117.32

The mean variations varied as follows:

16.57σ	20.54σ	21.97σ	13.96σ
14.49	13.67	12.58	12.41
12.14	10.93	11.62	12.19
11.89	9.08	10.12	9.85

	9.40	7.77	9.09	9.59
	10.59	8.04	9.92	9.09
	10.33	7.47	9.77	9.95
	9.77	8.86	9.07	8.88
Grand average,	11.9	10.8	11.76	10.74

Practice shortens the reaction-time and it increases the number of those reactions which may be called normal.

At the meeting of the American Philosophical Society was presented the following paper:

The Effect of Imperceptible Shadows on the Judgment of Distance, by E. B. TITCHENER and W. H. PYLE.

This paper reported the results of a repetition and extension of the work published under the same title by Dunlap in 1900. The observer is asked to compare the lengths of two continuous sections of a horizontal black line upon a white ground. In certain series, unknown to the observer, the experimenter throws upon the background angular shadows, so disposed as to convert the two lengths of the line into the two parts of the Müller-Lyer illusion. The question at issue is whether the imperceptible shadows have any influence upon judgment.

It is shown, first, that these subliminal shadows, even raised almost to the limit of perceptibility, have no influence whatsoever upon the judgments of distance passed by five observers. It is shown further, that shadows, so weak as barely to hold their form distinct, exert an influence upon judgment, comparable with the influence exerted by strong shadows; there is no sliding scale of illusion-effect, varying with the clearness of contour of the illusion-motive. It is shown, thirdly, that the observer is able, by voluntary direction of attention, to resist the solicitation of a strong illusion-motive, clearly presented. So much the more then will he, under the conditions of Dunlap's experiments, resist the solicitation of an illusion-motive which he cannot see, of whose presence in the particular experiment he is ignorant, and which is left out of account in the instructions given him by the experimenter. It follows from the whole investigation that if the subconscious is to be received into experimental psychology at all, it must find some other means of access than these imperceptible shadows.

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